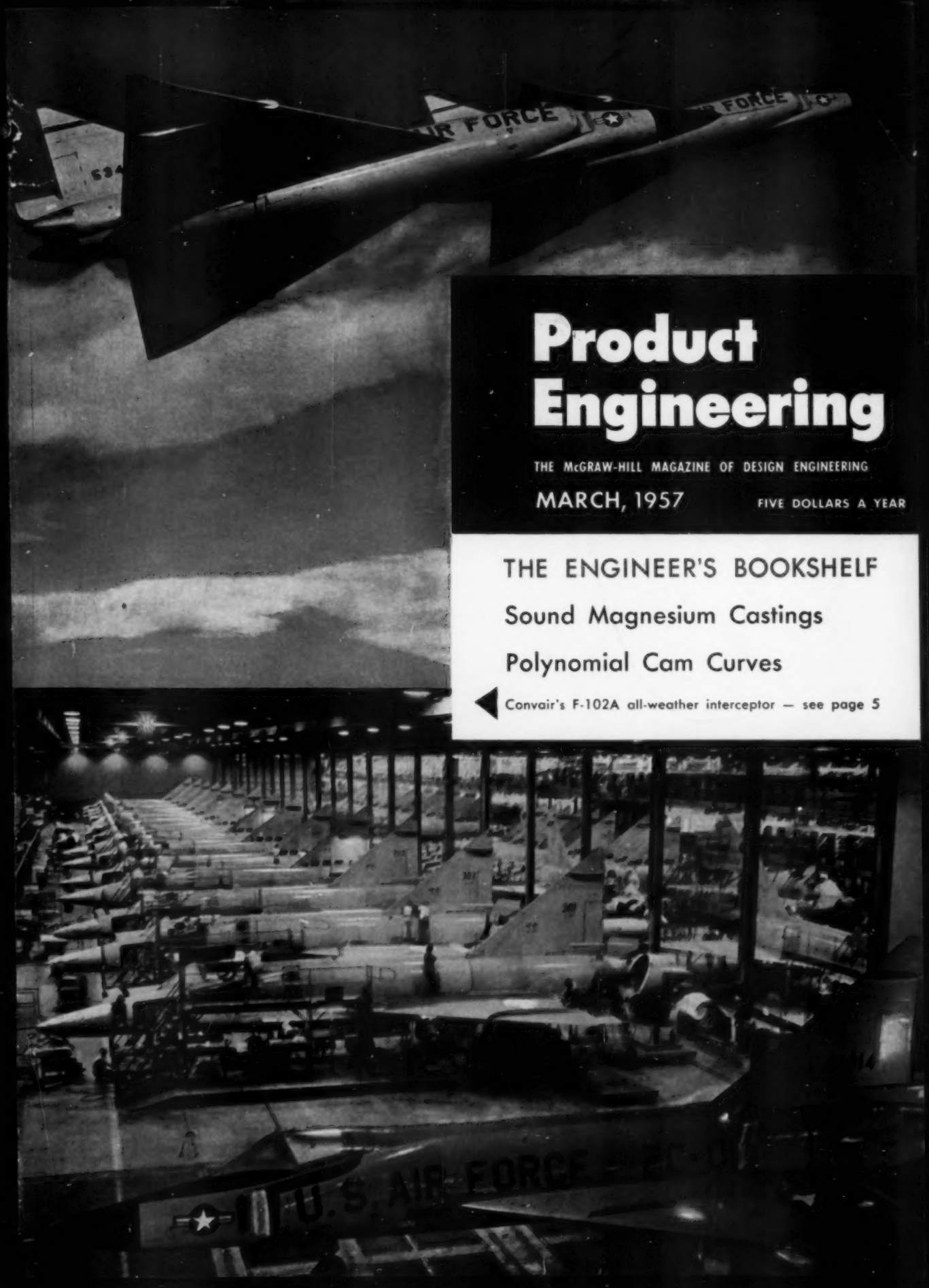

Product Engineering

THE McGRAW-HILL MAGAZINE OF DESIGN ENGINEERING

MARCH, 1957 FIVE DOLLARS A YEAR

THE ENGINEER'S BOOKSHELF

Sound Magnesium Castings

Polynomial Cam Curves

◀ Convair's F-102A all-weather interceptor — see page 5

TEST PROVES C/R MOLDED CUP

Conventional leather cup. Note rounded shape and thinness of material at heel.

C/R *molded* leather cup. Note sharp angle and full thickness of material at heel.

New molded C/R cups* stand up longer... cut down replacement costs

Compare the wear on these piston cups shown in the unretouched photographs above. They were tested in a hydraulic cylinder at 6000 p.s.i. for 3000 cycles. The one at the right is a Sirvis-Conpor molded leather cup. The other is a conventional leather cup. Features of the C/R molded cup that make it so obviously superior are greater density, the sharp, rather than rounded heel, and the fact that it is pre-formed to the shape which conventional cups are forced to assume under pressure. This eliminates operational stress and flexing that conventional cups undergo, and contributes greatly to longer service life.

Right now, molded C/R cups are providing greatly increased service life in hydraulic cylinders in such heavy duty applications as farm and road building equipment and steel mill equipment at oil pressures up to 3500 p.s.i., and 150 p.s.i. in air cylinders. If you face a difficult packing problem that requires high durability and efficiency . . . it will pay you to consider this new, improved C/R design.

Available in J.I.C. standard and other popular sizes. Write for complete size list.

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Offices in 55 Principal Cities. See your telephone book.

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CHICAGO RAWHIDE

Other C/R Products

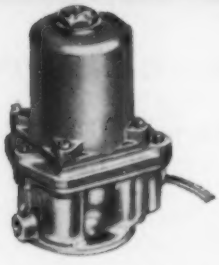
C/R Shaft & End Face Seals • Sirvene (synthetic rubber) molded pliable parts • C/R Non-metallic Gears

NEW Ross Starline

air control valve series

NEW long life

WHITE STAR
SPOOL SOLENOID



GOLD STAR
OIL-IMMERSED SOLENOID

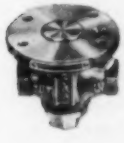
BLUE STAR MV

BLUE STAR TD

BLUE STAR WV

NEW match any head to any valve body!

STRAIGHTWAY NORMALLY OPEN

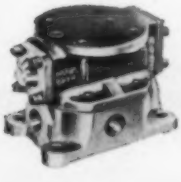


STRAIGHTWAY NORMALLY CLOSED

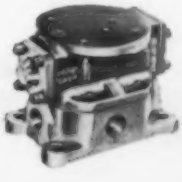
3 WAY NORMALLY OPEN

3 WAY NORMALLY CLOSED

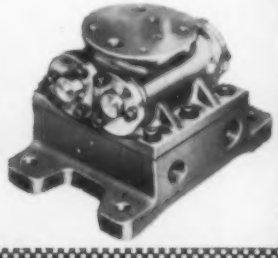
3 WAY NORMALLY OPEN



3 WAY NORMALLY CLOSED



4 WAY



Tests indicate a trouble-free life of over 25 million cycles for valves with the spool solenoid pilot section, and *more than 40 million for all other Starline* valves shown.

Heads and bodies are completely and instantly interchangeable. Sizes from ¼" to 1¼". Even *more* Starline models coming later. Write for Starline data file.

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Ross OPERATING VALVE COMPANY

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INSIDE INFO FROM HOLO-KROME

THE SECRET'S IN THE SOCKET!

Sharp hex socket corners mean less reaming —the payoff's on the production line with fewer damaged screws, less downtime and improved product appearance!

H-K's sharp socket corners resist reaming!

Compare These Other H-K Features!

COMPLETELY FORGED SOCKET HEAD . . . no drilling or broaching—metal fibers stay intact for stronger hex sockets.

SCIENTIFICALLY DESIGNED SOCKETS . . . depth carefully proportioned to give greatest head and socket strength, firmest key grip.

UNTAPERED WALLS . . . for better key fit, longer key and socket life, even tighter wrenching.

For the finest in Socket Screw products . . . for revolutionary SAME-DAY SERVICE, the name to remember is Holo-Krome!

LOOK INSIDE A HOLO-KROME SOCKET!

Send in the coupon below and we'll send you FREE an H-K Socket Cap Screw (we've omitted heat treating to let you get a better look at the mirror finish and sharp hex corners under the usual black finish). Look it over carefully, and see for yourself what a real difference H-K quality and skill can make!

Please send me FREE a Holo-Krome Socket Screw for my inspection.

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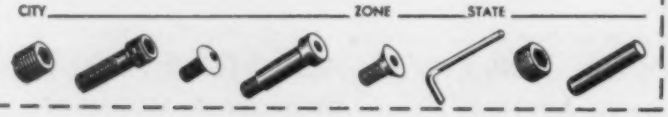
CITY _____ ZONE _____ STATE _____



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Product Engineering

MARCH 1957 Vol. 28, No. 3

The McGraw-Hill Magazine of Design Engineering

Redesigning Castings to Weldments ..... Omer W. Blodgett 135
Strength, rigidity, weight, cost, vibration and noise problems of machine components consisting of weldments.

Are You Paid What You're Worth? ..... Edward B. Peck 140
How engineering salaries have lagged; significant factors for salary administration; pricing of experience and merit.

Hydraulic Control Valves—III ..... John J. Pippenger 144
Details of construction, operation and maintenance of direct and pilot-operated flow control and check valves.

Design Features in New Products 150
Rotating thread-cutter; electric portable typewriter; coke car floors stud welded; generating plant in trailer; clutch-controlled paper feed; savings through stamping of heat-exchanger parts; static components excite diesel generator; gear-pinning machine.

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Common design faults responsible for unsoundness and increased costs.

The Engineer's Bookshelf ..... Richard M. Koff 167
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Fastening Studs and Pins to Plates ..... D. Mascio 194
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Computers Simplify Design of Polynomial Cams ..... M. Kloomok and R. V. Muffley 196
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Fatigue Strength of Bolts ..... Joseph Viglione 203
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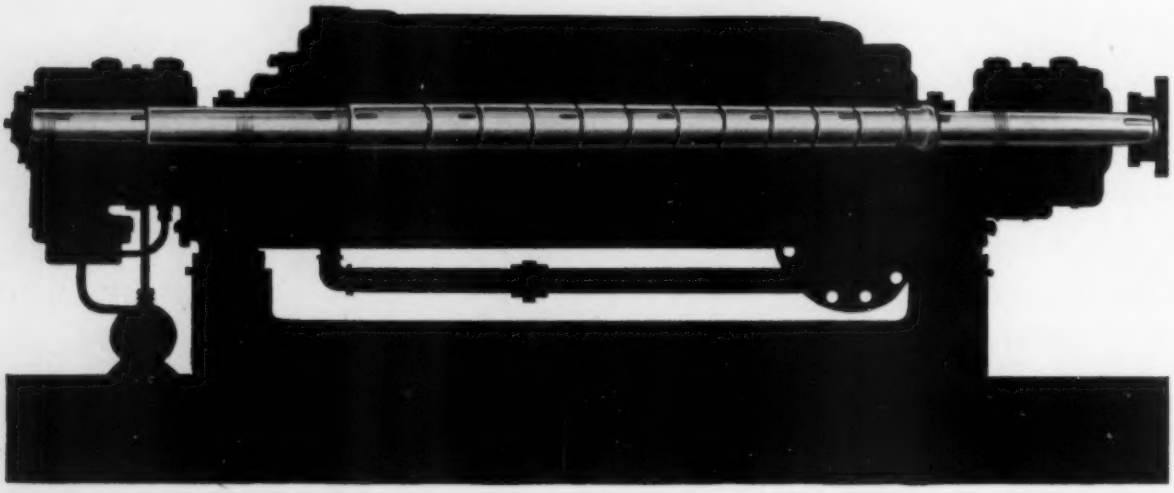
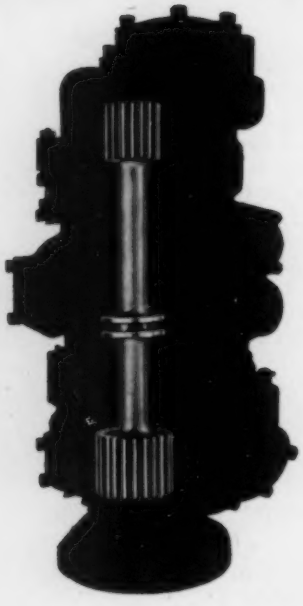
From Planes to Power Plants...

Pump Shafts of Armco 17-4 PH Stainless Cut Costs, Last Longer

Typical applications where unusual combination of properties of this special Armco Stainless Steel meets severe service requirements





In aircraft, power stations or chemical plants, pumps must be designed to give long, unfailing service even under rugged operating conditions. That's why many designers of small hydraulic units as well as huge multi-stage, high-pressure centrifugal pumps, specify shafts made of Armco 17-4 PH Stainless Steel.

They know that this special precipitation-hardening stainless steel, with a typical tensile yield strength of 180,000 psi, effectively resists high torsional and bending stresses. Its good fatigue strength plus corrosion resistance guards against early failure. In addition, a typical yield strength of 110,000 psi at 900 F, and a low coefficient of thermal expansion, assure performance according to design where operating temperatures reach the range of 900 F.

Simplifies Production

Besides its unusual combination of mechanical properties, Armco 17-4 PH also offers outstanding production advantages. It can be readily machined in the annealed condition, then fully hardened by heating at 850 to 900 F for one hour and air cooling. This simple, low-temperature heat treatment eliminates scaling and distortion. In most cases parts can be *finish-machined before hardening.*

For parts in your products where conditions call for an extra-high strength material, consider the design and production advantages you get with Armco 17-4 PH Stainless. It is produced in bars, wire and billets and can be forged as well as cast.

For complete information on this special Armco Stainless Steel, just write us at the address below.

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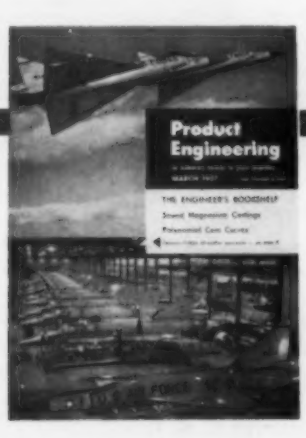


Interesting to Note . . .

The Birth of Industrial Tubes

When Enrico Caruso sang from the New York Metropolitan Opera House in 1910, he was contributing to the first musical radio broadcast in history. The production was presented not by a musical entrepreneur, but by Lee de Forest, inventor of the audio tube.

Seven years before the history-making broadcast, while still in New York, de Forest was heating two platinum electrodes with a Bunsen burner. One electrode was connected to an aerial, the other to ground through a telephone receiver. To his surprise, he received wireless signals from a ship in New York bay. He continued experimenting, next using a bulb that contained a carbon filament and a platinum plate. He ionized the gases within the bulb by connecting the plate to a source of high voltage. His next step was the introduction of a third electrode within the bulb, consisting of a piece of wire bent back and forth and located close to the filament. This three-electrode tube, the "triode," was the prototype of the billion radio tubes since produced.

The work of de Forest laid the groundwork for the production of today's industrial tubes. An article on the application of these tubes begins on page 189.

The Fire Bomb

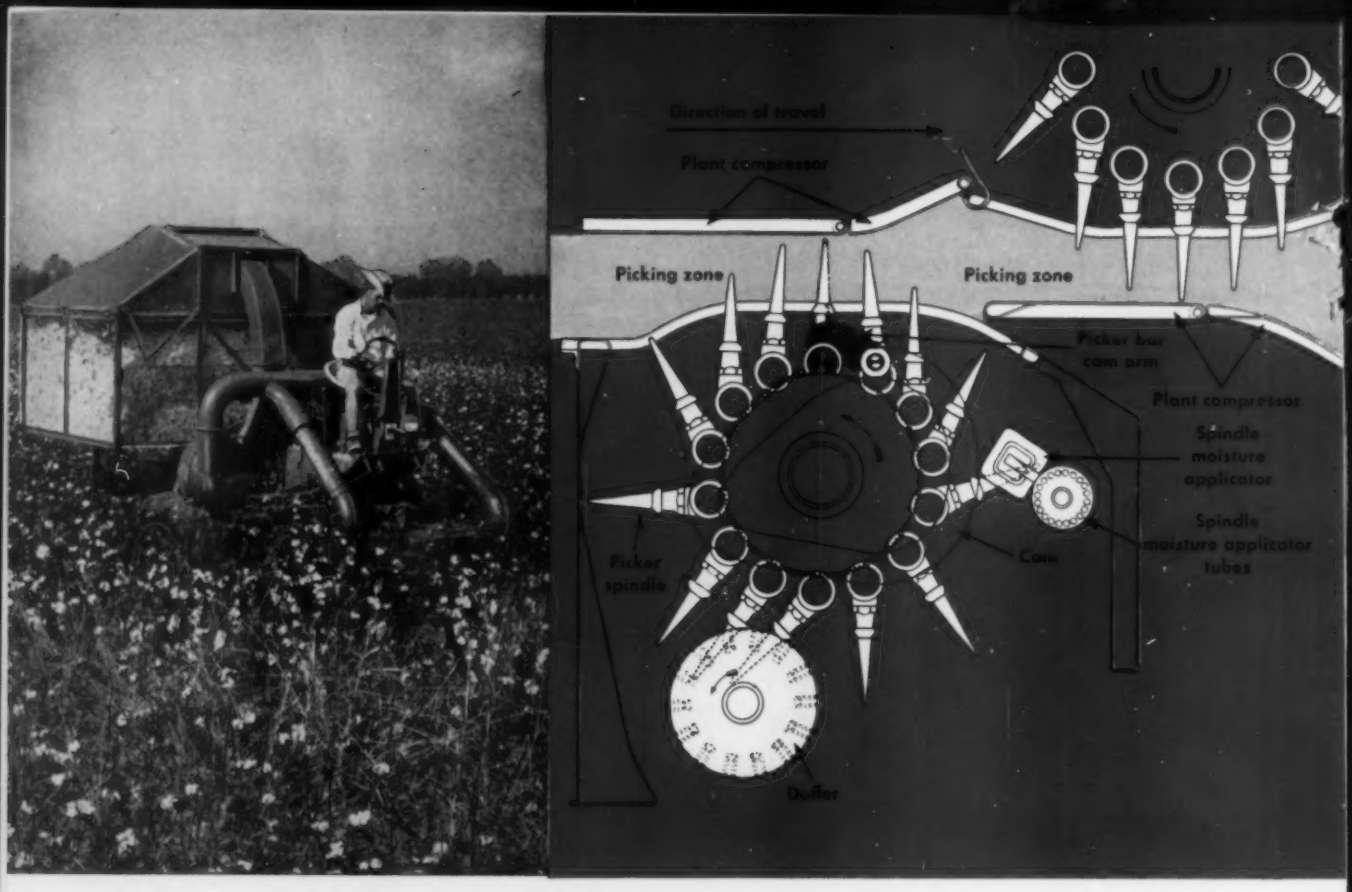
Shortly before the defeat of the Axis powers in the First World War, German scientists devised a fiendish aerial incendiary bomb made of a relatively new metal—magnesium. Before the bomb could actually be tested in combat, the German High Command decided that such an instrument of destruction would engender greater antagonism toward the nearly defeated Axis powers and result in sterner armistice terms. The "magnesium bomb" was shelved.

Came the Second World War, Dunkerque and the fall of France. By August, 1940, Great Britain was alone in the war and the Battle of Britain had begun. The Germans had full mastery of the air. Their planes were not only faster than all others, but their bombers carried heavier bomb loads than British experts had figured possible. The incendiary of World War I was now being used with great success—and in a different way. On a routine air raid in the fall of 1940, a German plane was hit by a British anti-aircraft crew. The pilot of the flak-ridden ship elected to crash land on English soil rather than risk the Channel

(*Continued on page 7*)

THIS MONTH'S COVER

Convair's F-102A delta-wing all-weather interceptor can fly at supersonic speeds and stratospheric altitudes. Instead of building the airframe and then installing equipment, Convair set up a mechanized line of 89 assembly stations at which subassembled components of manageable size are built in, as in automotive practice. "Hard" tooling was used from the beginning; first production plane was delivered just 16 months after the program began.



How angular power transmission makes still another improved design practical

This cotton picking machine is just one of many, many products improved and made more practical through the flexibility of angular power transmission.

Using the angle of transmission shown at right, the makers of the machine can put a whole row of spindles on a bar and drive them with a single source. The spindles pluck bolls gently from the cotton plant and deliver them unmarred to a collecting basket.

Besides this flexibility, bevel gear transmissions usually weigh less, cost less, and carry heavier loads.

Our engineers are ready at all times to help you work out applications for bevel and hypoid gears.

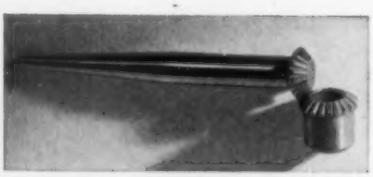
They can discuss such items as mountings and lubrication. They can produce and test prototypes of your drives.

Finally, they can advise you on the proper machinery to use to produce top quality gears in large quantities at low costs.

Please write whenever you have an application in mind.

Meanwhile, you'll find these Gleason Technical Handbooks helpful:

20° straight bevel gear system
Spiral bevel gear system
Zerol® bevel system



The cotton picking machine shown above, uses 420 of these tapered spindles in its picking drum (diagram). The machine slashes picking costs by as much as 60%.

GLEASON WORKS

Builders of bevel gear machinery for over 90 years

1000 UNIVERSITY AVE., ROCHESTER 3, N. Y.

Interesting to Note . . . .

crossing. The pilot was captured and his plane dismantled. When analyzed, the plane's structure was found to contain a large percentage of magnesium alloy.

News of the war potential for magnesium caused Washington to up its production figures immediately to 700 million pounds per year. The same war authorities had been content with 6 million pounds only two years before. Common design defects found in the castings of this metal are discussed in an article appearing on page 166.

The Slide Rule That Lost Its Origin

Few changes have been made in the design of slide rules since Robert Bessaker first conceived the idea in 1654. More scales have been added and the slide rule's applications have increased, but its actual size and principle have remained relatively constant. Offshoots of Bessaker's original rule were bound to come about. One of these, pictured above, was a bamboo box with an octagonal slide usable in all eight positions. This weird antique contains over 175 lines of data from the specific gravity of rum and stone to the phases of the moon. The history of this instrument is as obscure as its actual purpose. It was purchased in the Far East during the 19th century and given to Keuffel and Esser Co. Neither engineers at K & E, nor at the Franklin Institute, were able to handle the device or shed any light upon its origin. It has been suggested, however, that it belonged to a sea captain because of its data on navigation and astronomy. The slide rule pictured below the antique was one of the first rules made in this country by K & E about 1887. It is interesting to note the similarity between this rule and the ones made and used today.

The aid and time saving feature which the slide rule affords the designer in his daily calculations has been overshadowed by the ever increasing applications of high speed computers. Use of digital computers in cam design for plotting complex curves is the subject of article appearing on page 196.

Misguided Ladies

The first practical typewriter, invented by Christopher Sholes in 1867, was expected to be more of a novelty than a labor-saving device. Mark Twain, the first American novelist to prepare a manuscript by typewriter, dubbed his machine "the curiosity-breeding little joker." One of the greatest barriers to the typewriter's immediate success was a lack of trained operators. According to Remington Rand, the New York YWCA pioneered typing instruction at its Ballard School. This plan was immediately branded "an obvious error in judgment" and the feminine managers of the school called "well-meaning, but misguided ladies." The female mind and constitution were then considered "too frail" to survive a six-month course in typing. Yet it was this small group of stalwart girls who acquired typing experience and invaded the men's world of politics and business.

As on all practical machines that live, refinements followed fast. One of the current developments in the typewriter industry is the electric portable. Problems encountered in designing this machine are discussed on page 154.

The Engineer's Library

Engineering libraries, the storage houses of our acquired scientific knowledge, play an ever-important role for the designer—and are of increasing importance as products become more complex. The Engineering Societies Library, 29 West 39th St., New York 18, N. Y., is one example. It was initiated in 1901 when the late Schuyler Skaats Wheeler, an electrical engineer and inventor of the electric buzz fan, requested a fireproof building to house his prize collection of rare books on electricity. Wheeler acquired this collection, which contained over 7000 titles, from the English physicist, Latimer Clark. Fortunately, a group of engineering societies, (ASME, ASCE, AIMME and AIEE) agreed to accept these books and house them in a fireproof building in New York. The library is today the largest single engineering library in the world, containing over 173,000 volumes and receiving more than 1400 periodicals.

Although only society members are allowed to borrow books, there are many facilities available to the public. Publications in any language can be translated, and photoprints and microfilm service is provided. Literature searches are made for all purposes including that of disclosures related to patents. Merely by stating the exact subject, period of time to be covered and languages desired covered, a user can receive a bibliography, the fee depending upon time spent in searching. Additional information may be acquired by contacting the library director, Ralph H. Phelps.

This type of library is but one of the many aids the engineer can use in his daily work. His personal and company library is another. A guide for the building of such a library, entitled "The Engineers Bookshelf," begins on page 167.

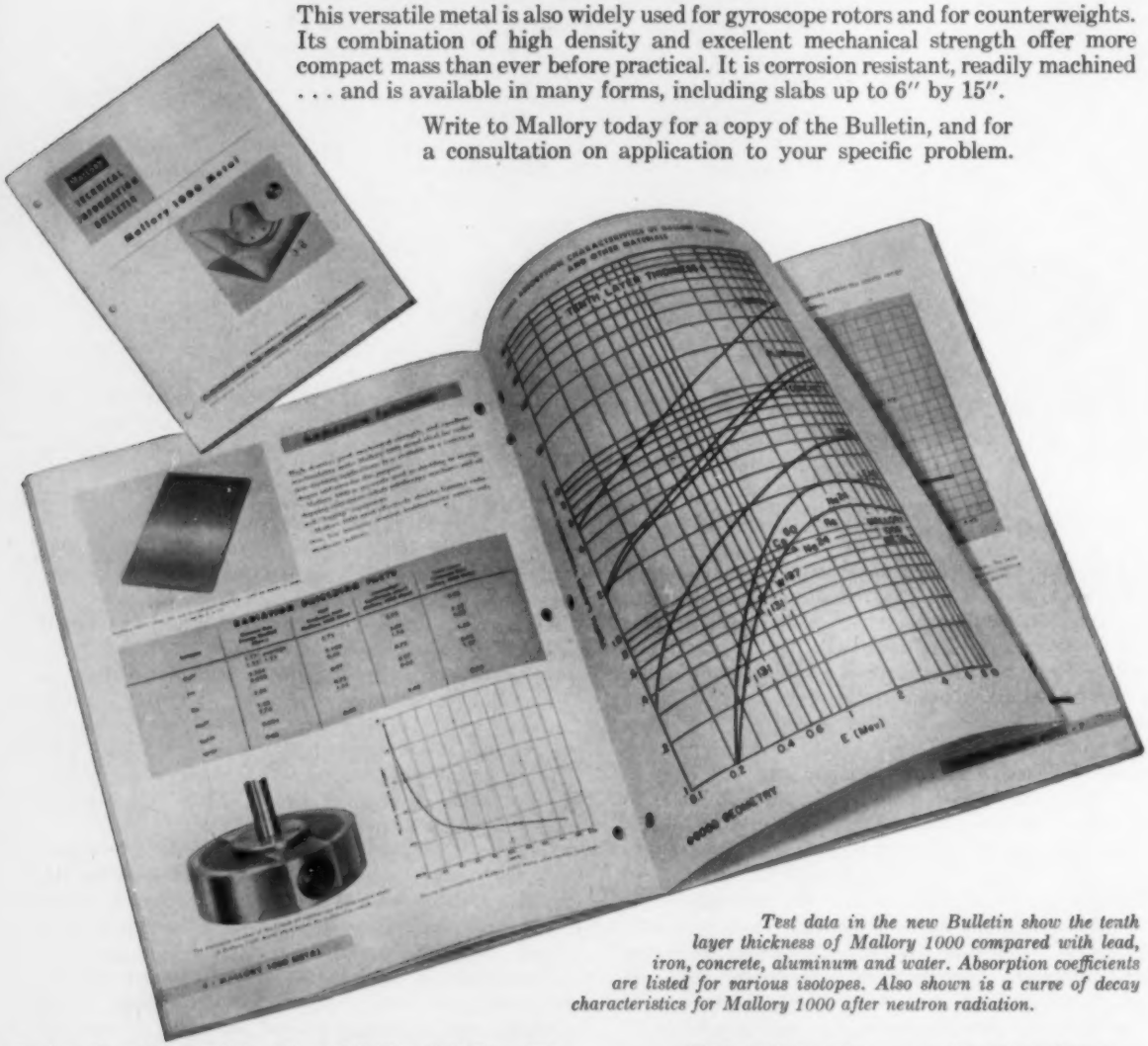
Latest Design Data on Radiation Shielding Properties of MALLORY 1000 Metal

When you are designing radiation shields for atomic research, radioactive isotope source containers, or similar applications in nucleonics, you can find valuable information on the unique characteristics of Mallory 1000 in this new Bulletin.

A product of Mallory's extensive experience in specialized metallurgy, Mallory 1000 is a high density powder alloy of tungsten, nickel and copper. It has substantially higher efficiency than lead for absorbing radiation.

This versatile metal is also widely used for gyroscope rotors and for counterweights. Its combination of high density and excellent mechanical strength offer more compact mass than ever before practical. It is corrosion resistant, readily machined . . . and is available in many forms, including slabs up to 6″ by 15″.

Write to Mallory today for a copy of the Bulletin, and for a consultation on application to your specific problem.



Test data in the new Bulletin show the tenth layer thickness of Mallory 1000 compared with lead, iron, concrete, aluminum and water. Absorption coefficients are listed for various isotopes. Also shown is a curve of decay characteristics for Mallory 1000 after neutron radiation.

In Canada, made and sold by Johnson Matthey & Mallory, Ltd., 110 Industry Street, Toronto 15, Ontario.

Expect more . . . get more from

P. R. MALLORY & CO. Inc.

MALLORY

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For information on titanium developments, contact Mallory-Sharon Titanium Corp., Niles, Ohio.

Developments

To Watch

HIGH-STRENGTH ALUMINUM CASTING ALLOY . . . .

. . . . is reported to be such an improvement over existing alloys that its use may result in the replacement of many expensive forgings by more economical castings, according to North American Aviation's Production Development Lab., Los Angeles 45, Calif. Savings in weight, cost, and production time are possible with superior strength and castability in either permanent or sand molds, compared to other aluminum alloys. With the new alloy, a part cast in a sand mold has a minimum tensile strength of 42,000 psi, and 45,000 psi in a permanent mold. This compares with 30,000 psi and 33,000 respectively, for other alloys. Called 42B, the new alloy has a good balance of yield and elongation. Any foundry using ordinary methods can cast the alloy.

NYLON AND CHROMIUM LEATHER TRANSMISSION BELT . . . .

. . . . after stretching at elevated temperature, has a tensile strength of 2000-3000 kg/cm², an elongation at failure up to 35 per cent, and the modulus of elasticity 5500 kg/cm². High flexibility and optional frictional force are characteristics of the new belt. Called Extremultus, the type 5C can transmit 30 hp with a velocity of 50 m/s and a belt width of 1 cm. Transmission ratios of up to 1:20 are possible, even with small disk diameters and looping angles of 100 deg, thus permitting the use of high speed motors. For example: a 500 hp compressor using an Extremultus belt was able to reduce the distance between axes from 6000 mm to 3300 mm. A new machine was installed later in the space made available. No idler pulley drive is necessary, which saves power and makes the machines less noisy. The belts are resistant to temperatures between —22 and 160 F, as well as gasoline and oil and other compounds except concentrated organic and inorganic acids, phenols and cresols. The manufacturer is Sieglingriemen, Hannover, Germany.

POWER TRANSISTORS FOR SWITCHING 1 KW LOADS . . . .

. . . . have just gone into production at the Delco Radio Div. of General Motors, Kokomo, Ind. The power needed to control a load of 1 kw with a transistor switch is one watt. Two specific advantages accruing from a transistor switch are: switching an electrical current from a great distance using only thin wiring, and arcing at the switch is eliminated. In its ON position, current flows directly across the transistor, and voltage drop is negligible. It is possible to convert d-c into a-c with a transistor switch operating like a vibrator. This a-c voltage is then stepped up with a transformer. It is also possible to control motors directly with an amplifier using radio transistors. Another application is as an electronic ballast for fluorescent lamps, lighting the lamps immediately, and eliminating the delay and flickering.

ALLOY IMPROVES MAGNETIC AMPLIFIERS . . . .

. . . . switching and memory devices, pulse transformers, and power transformers, and will permit reductions in the size of magnetic components without sacrifice in performance. Bell Telephone Labs., 463 West St., New York 14, N. Y. says that it has higher permeability and lower hysteresis losses at higher flux densities

(Continued on page 10)

than any other material available. Called Supermendur, its composition is 49 per cent iron, 49 per cent cobalt, and 2 per cent vanadium, which is similar to 2V-Permendur, a magnetic alloy developed at Bell Labs years ago. Maximum permeability is 66,000 at 20,000 gausses; coercive force 0.26 oersted; and saturation 24,000 gausses. Core losses are under 6 watts per pound at 400 cycles at a flux density of 100,000 lines per square inch. The material can be cold rolled from 0.090 to 0.0003 in. without intermediate anneals. Power transformer cores of 0.004 in. or 0.002 in. Supermendur tape will have an output more than 30 per cent greater than comparable grain-oriented silicon steel cores.

HIGH STRENGTH ALLOY FOR 1200-1400 F RANGE . . . .

. . . . was developed by General Electric's Flight Propulsion Lab., of the Aircraft Gas Turbine Div., Cincinnati, Ohio, for key jet engine components, specifically jet engine wheels, operating in this temperature range. An iron-base alloy, it is reported to have a strength-to-weight ratio 25-40 per cent better than comparable materials in this temperature range today. Called the J1300, the alloy is the latest of a line of GE alloys, which includes the J1500 and J1570 materials presently in use. The J1300 will improve jet performance while reducing over-all engine weight by several hundred pounds. The alloy has a low content of strategic metals (no cobalts, no columbium, and little nickel), and a life of 1000 hr or more at 15,000 psi and 1500 F. The material was found to be a good high-strength bar and forging material in the medium temperature range, and to have good potential as a high strength sheet in the 1200-1400 F range.

HIGH-GRADE STEEL PRODUCED IN A ROTOR . . . .

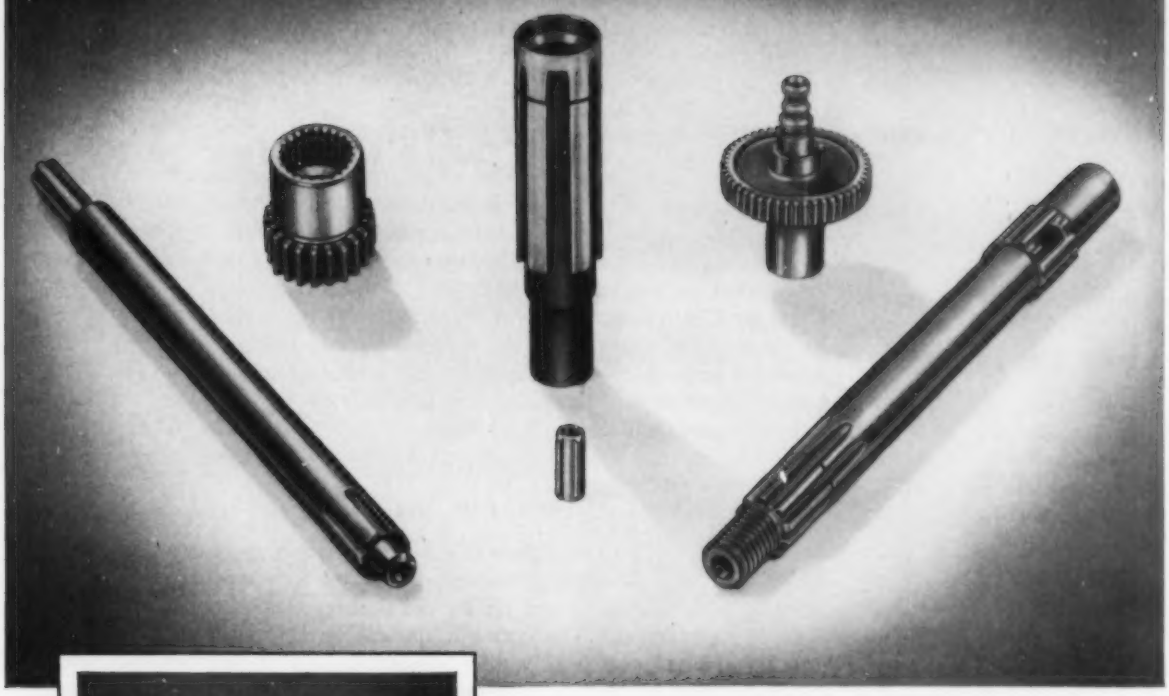
. . . . by a German method which is a refinement of the Austrian invention of the oxygen blast converter. The latter procedure produces high-grade steel in larger quantities without the use of Thomas converters. The German method has pure oxygen blown into the bath surface of the converter, but instead of decarburizing the steel in the usual furnaces, a rotor is used. By rotating the rotor once every two minutes, an overheating of the furnace coating and thus fast erosion is avoided. The rotor permits better slag melting, with the result that top grade steel can be produced. The first rotor is a 50 ton unit into which compressed oxygen is forced through water cooled nozzles. The oxygen lance has the form of a fork so that the oxygen can be blown into the 14 yd long rotating cylinder partially above and partially below the surface of the steel bath. Carbon-monoxide is burned in the rotor, in contrast to converters where burning takes place outside. A rotor has been installed at Huettenwerk Oberhausen A. G., Oberhausen, Germany. Up to 10% of the steel is obtained and 60 to 100 tons can be refined in one hour.

HIGH STRENGTH WITHOUT HEAT TREATING . . . .

. . . . is possible with a process of drawing steel bars at temperatures significantly above room temperature but below the lower critical temperature. Because of the individual processing of each bar, the dimensional tolerances, surface finish and good machinability associated with cold finished bars have been included in a bar product which also has the strength developed by heat treatment. The process is called elevated temperature drawing, and the properties depend upon: the selection of a particular material composition of steel; the control of the amount of deformation by reduction; and the temperature at which deformation is carried out. The bar is deformed between 200 F and below the lower critical

(*Continued on page 12*)

Simple Or Intricate Splines and Serrations Are Jobs For G.S. ENGINEERING



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Specialties, Inc.
2635 WEST MEDILL AVENUE
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SPURS • SPIRALS • HELICALS • BEVELS • INTERNALS
WORM GEARING • RACKS • THREAD GRINDING

WORLD'S LARGEST EXCLUSIVE MANUFACTURERS OF FRACTIONAL HORSEPOWER GEARING

The extreme uniform accuracy of splines and serrations in G.S. Gearing is the result of 41 years of specializing in the mass-production of Small Gearing exclusively! Critical customers from coast-to-coast specify "G.S." again and again for the engineering skill and production efficiency only these long years of highly specialized experience can give. ★ The group of components shown above feature internal, external and involute splines and serrations. "Parallel Side" splines are multiple keys. They can be made to either a major diameter, minor diameter, or side fit with mating part. G.S. generates the externals by the hobbing or shaping process . . the internals by broaching or shaping. Involute splines are multiple integral keys having a pressure angle of 30°. They offer the advantage of greater strength. Involute serrations are essentially involute splines with 45° pressure angle. They are made for side fit applications only. ★ Whatever *type* of Splining or Gearing YOU require, however simple or intricate, you can place implicit confidence in G.S. to *consistently* supply TOP quality at moderate cost. Send drawings or descriptions today! Let our skilled engineers suggest the ONE best and most economical application for the job. There's no cost or obligation.

SEND FOR FREE *6-page Small Gearing Guide. It describes 80 types and applications. Contains useful charts . . a valuable aid to anyone interested in Small Gearing. Use company letterhead, please. No obligation, of course. Write today!*

FRACTIONAL HORSEPOWER GEARING

41 Years of Specializing in Small Gearing!

temperature. A steel bar product made by this process and offered commercially by the LaSalle Steel Co., Chicago 80, Ill., has a 30 Rockwell C; a tensile strength of 140,000 psi and a yield strength of 125,000 psi. It machines about 25 per cent faster than annealed alloy steel, and up to 100 per cent faster than alloy steel heat treated to the same strength level.

ENCOURAGING THE DEVELOPMENT OF ATOMIC ENERGY . . . .

. . . . has been suggested in the form of government indemnification to supplement private insurance. This would permit industry to participate in the development of atomic energy while giving assurance to the public that injuries suffered as a result of the development will be compensated. This was the recommendation in a report prepared by the Legislative Drafting Research Fund of Columbia Univ. for The Atomic Industrial Forum, Inc. The report is in agreement with the principles of a bill which was reported favorably by the Joint Committee on Atomic Energy in the last Congress, but not acted upon. The report recommends, however, that the indemnity program cover government contractors as well as licenses, and that no limit be placed on the amount of indemnity.

PREFERRED AUTOMATIC FREQUENCY CONTROL CIRCUIT . . . .

. . . . which is a practical solution to a frequently recurring circuit design problem is part of a program of The National Bureau of Standards to minimize design effort, increase reliability, and reduce the military's production costs of military electronic equipment. The circuit is applicable wherever a 30 mc intermediate frequency is used with pulse widths between 0.5 and 5.0 microseconds, and duty factors between 50 and 500 millivolts. The portion of the automatic frequency control circuit system between the mixer and the local oscillator is usually a self-contained sub-assembly and is a logical choice for a preferred circuit. A preliminary study of a number of existing circuits showed that they are composed of a few basic circuits, which NBS found feasible to standardize.

AND IN ADDITION . . . .

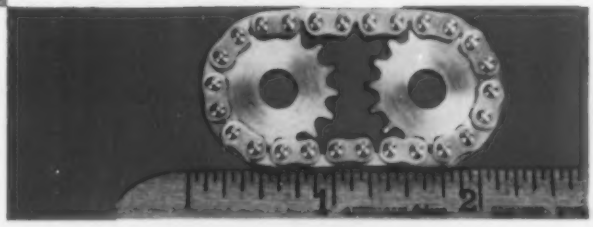
. . . . the Air Force Research Center in Cambridge, Mass., has developed a technique for producing an almost pure silicon which will permit the production of transistors capable of temperatures up to 600 F. . . . The Porcelain Enamel Institute is talking about low temperature porcelain enamels that fire in the 1000-1350 F range; at these temperatures it can be applied to lighter gage and larger size panels without fear of warpage. . . . The first earth satellite to be sent aloft in the IGY will have a 48 channel telemetering system that weighs only 3.2 oz, with batteries weighing 2.8 oz to insure operation for more than 3 weeks; the system uses magnetic cores and switching transistors. . . . The British firm of Pye Ltd. has a television camera 24 in. long and 3 in. in dia to inspect the inside of atomic reactor pressure vessels; the camera carries its own lighting and can be attached to a mechanical grab which can be lowered into fuel channels of the reactor's graphite core. . . . The Ford Thunderbird for 1958 will be completely restyled with reports indicating that a 5-passenger model will be available. . . . Also from Ford Co., indications are that the Continental Mark II will see the light of day for the last time in the 1958 or 1959 model; not exactly popular as a 2-door model with the people who have $10,000 to spend, it will reappear as a 4-door Lincoln Continental. . . . Solar Aircraft Co., San Diego, Cal., has the Navy's first value analysis contract for a single manufactured item—a 50 hp gas turbine of its own manufacture. Previous Navy valve engineering work involved analysis of entire vessels.

Here's full-scale efficiency in a fractional hp drive

CHAIN AS SMALL AS THIS

SPROCKETS AS SMALL AS THIS

A COMPLETE DRIVE AS SMALL AS THIS



LINK-BELT 3/16-in. pitch Silent Chain is smooth, quiet, positive at high or low speeds

Here's the ideal drive for limited-space applications. Despite its pitch of only 3/16 inches . . . weight as little as .07 pounds per foot — this durable Link-Belt drive is better than 98% efficient. In fact, it often replaces expensive, precision-cut gear trains.

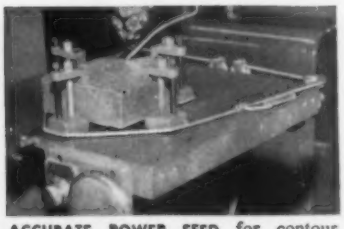
It's available in carbon and stainless steels . . . for ratios up to 12:1, speeds over 7500 rpm. Book 2510 explains outstanding features, including tooth and link form which eliminates chordal disturbance. Write for your copy to LINK-BELT COMPANY, Dept. PE, . Prudential Plaza, Chicago 1, Illinois.

LINK-BELT

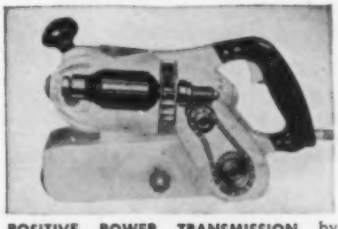
SILVERSTREAK SILENT CHAIN DRIVES

Link-Belt 3/16-in. pitch silent chain is installed as original equipment on

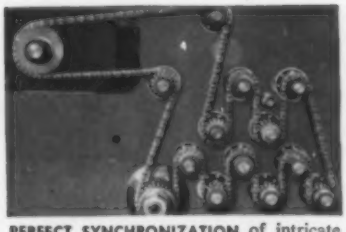
aircraft	portable planers
bread slicers	portable sanders
button making machines	radar equipment
cameras	recording machines
cigar making machines	rubber slicing machines
looms	sealing machines
meters	sewing machines
motion picture machines	timing devices
oil burners	typewriters
packaging machinery	vending machines



ACCURATE POWER FEED for contour shaping machine is assured by Link-Belt 3/16-in. Silverstreak silent chain.



POSITIVE POWER TRANSMISSION by Link-Belt 3/16-in. silent chain drive aids portable belt sander efficiency.

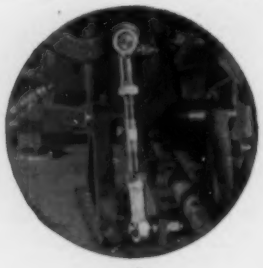


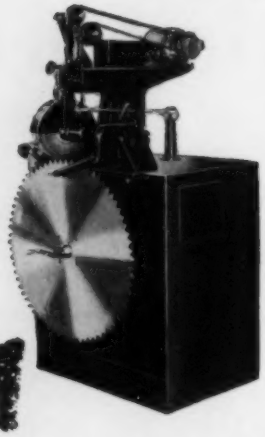
PERFECT SYNCHRONIZATION of intricate 14-wheel drive is maintained by Link-Belt 3/16-in. Duplex silent chain.

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World. 14,251

These applications demonstrate the self-aligning ability of the HEIM Unibal

This linkage controls the shuttle motion of the label loom made by Fletcher Works of Philadelphia. This application visually demonstrates the ease with which misalignment can be corrected.



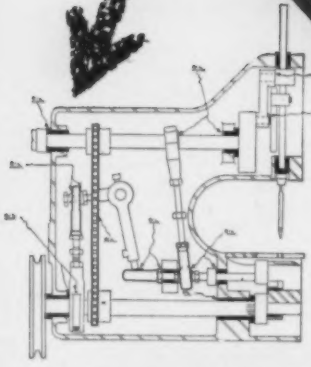


On this Armstrong Sharpener, which handles saws up to 120" in diameter, the push-pull rod with a Heim Unibal Rod End at each end, provides the universal motion for changing direction of the grinding wheel smoothly, quietly, and with precision for extreme sensitivity in grinding fine teeth.

Where shaft misalignment must be corrected . . .

The HEIM *Unibal* ROD END

is a single ball rotating in a bronze bearing race. It offers freedom of movement such as cannot be obtained with any similar mechanism. As a self-aligning bearing, it compensates for designed or unavoidable shaft or stud misalignment. Because of the large area of contact between the ball and the bronze bearing inserts, much greater load ratings are possible for substantially smaller envelope dimensions.



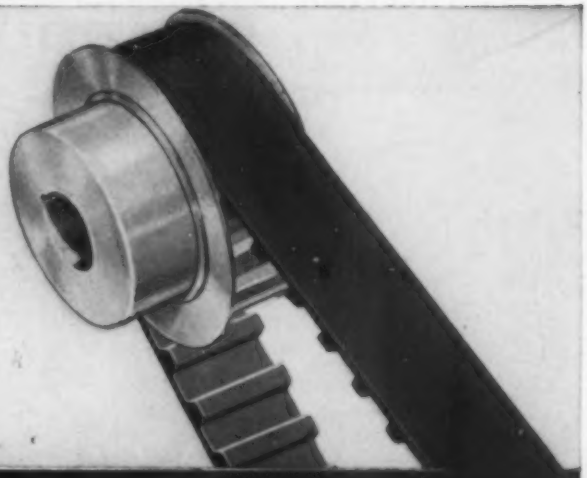
The Minneapolis Sewing Machine Co. uses Heim Unibal Rod Ends to take care of a 25° operating misalignment in the linkages in their model H-150 portable sewing machine.

Please feel free to write our engineering department about your linkage problems, and be sure you have sufficient copies of the Heim catalog for all designing, operating, and purchasing departments.

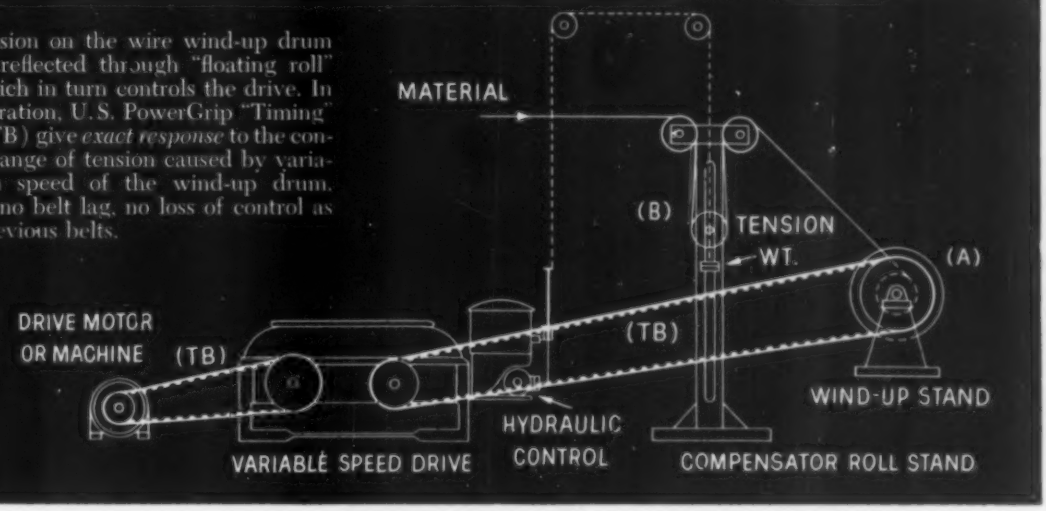
THE HEIM COMPANY/Fairfield, Connecticut

US RUBBER *PowerGrip "Timing" Belts*

How a designer licked the wind-up problem in a highly sensitive machine



The tension on the wire wind-up drum (A) is reflected through "floating roll" (B) which in turn controls the drive. In this operation, U.S. PowerGrip "Timing" Belts (TB) give *exact response* to the constant change of tension caused by variations in speed of the wind-up drum. Hence, no belt lag, no loss of control as with previous belts.



The schematic drawing illustrates a "floating roll," one of the most sensitive and precise methods of controlling tension in a web of material—whether it be wire, paper, cotton, threads, plastic or strips of metal. It is one more example of U.S. PowerGrip "Timing"® Belt's ability to simplify and improve a power transmission unit . . . one of the reasons why the invention of this belt was recently awarded the Franklin Institute's Edward Longstreth Medal for "Invention of High Order."

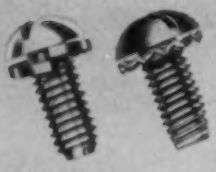
Whether for original equipment or plant conversion, U.S. PowerGrip offers all these advantages:

- *no slippage, no take-up—allows short centers, high ratios.*
- *absence of metal-to-metal contact—eliminates need for lubrication and housing devices.*
- *handles speeds up to 16,000 F.P.M. or so slow as to be imperceptible to the eye.*
- *close to 100% efficiency.*
- *imbedded with steel cables for high tensile strength.*
- *constant angular velocity.*

These belts—plus expert engineering service—are obtainable at "U.S." power transmission distributors, at any of the 28 "U.S." District Offices, or by writing us at Rockefeller Center, New York 20, N. Y.

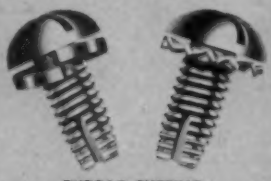
US RUBBER **Mechanical Goods Division**

United States Rubber



SPRINGTITES AND SEMS

SNAP RINGS

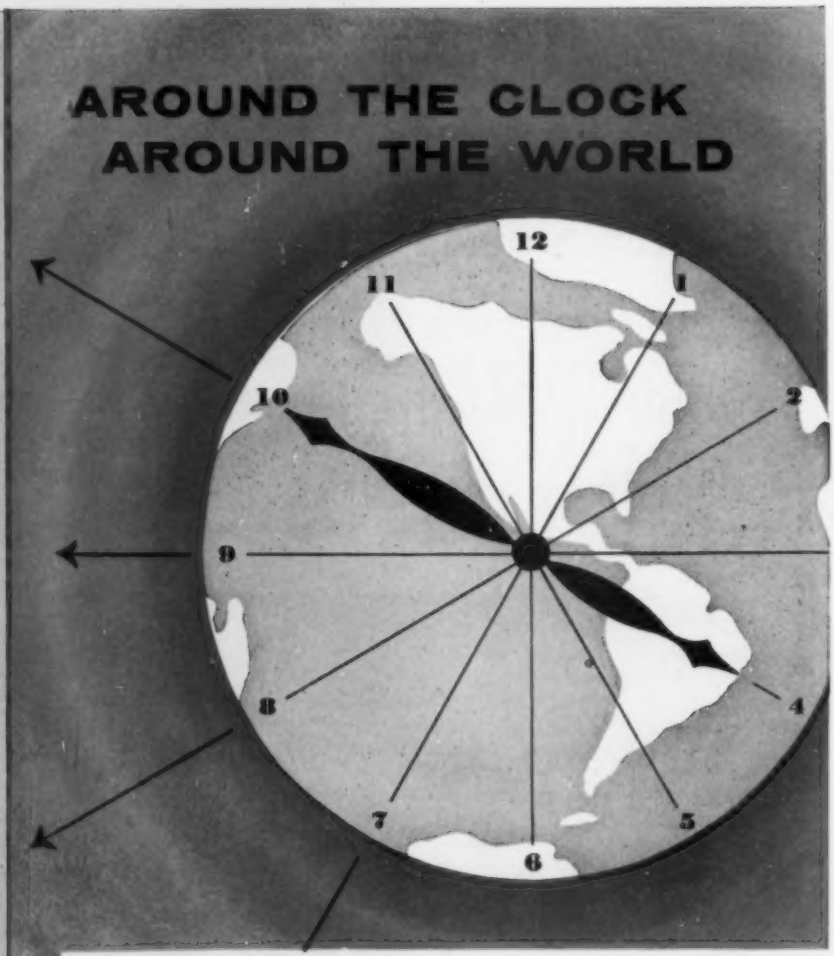


THREAD-CUTTING SPRINGTITES AND SEMS

EATON KEPS®

HOZ-FAS-NERS®

SPRING LOCK WASHERS



Eaton-Reliance Fasteners Keep Assemblies Tighter Longer

Used to advantage wherever assemblies are fastened together, Eaton-Reliance products will be found throughout industry . . . railroad, automotive, appliance, electric, heavy and light machinery, aircraft, and many others. They are manufactured of quality controlled materials to rigid specifications, and are designed to reduce assembly costs and speed up production. There's an Eaton type fastener for your particular needs. Send for free Engineering Bulletin giving details. Just name the fasteners in which you are interested.

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OFFICE and PLANTS: 515 Charles Ave. MASSILLON, OHIO

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PRODUCTS: Sodium Cooled, Poppet, and Free Valves • Tappets • Hydraulic Valve Lifters • Valve Seat Inserts • Jet Engine Parts • Rotor Pumps • Motor Truck Axles • Permanent Mold Gray Iron Castings • Heater-Defroster Units • Snap Rings Springtites • Spring Washers • Cold Drawn Steel • Stampings • Leaf and Coil Springs • Dynamatic Drives, Brakes, Dynamometers

Forethought costs less than Afterthought so . . .

Design These in When you Begin!

If you need mechanical or electrical counters in any of your new products, here's a word to the cost-wise designer: *Design them in, when you begin . . . don't tack them on later.*

Series 1370 High Speed Counter (1500 to 2500 rpm) built into a wide variety of equipment.

For if you'll give us a chance to work with you, right from the beginning, chances are we can save you time and money by adapting or modifying a *standard* Veeder-Root Counter to your needs . . where you might get into a costly special job if you went about it alone. What's more, you save time in your engineering, purchasing and assembly departments.

Count on Veeder-Root to help you in every way . . . from design to delivery. Write:

Everyone... Can Count on Veeder-Root

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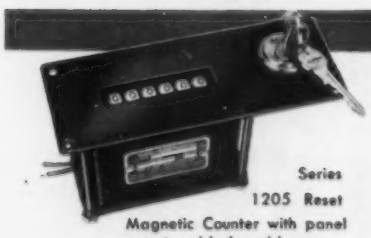
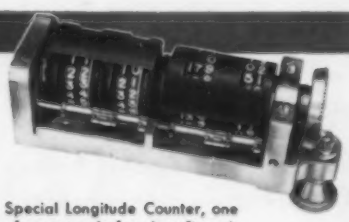


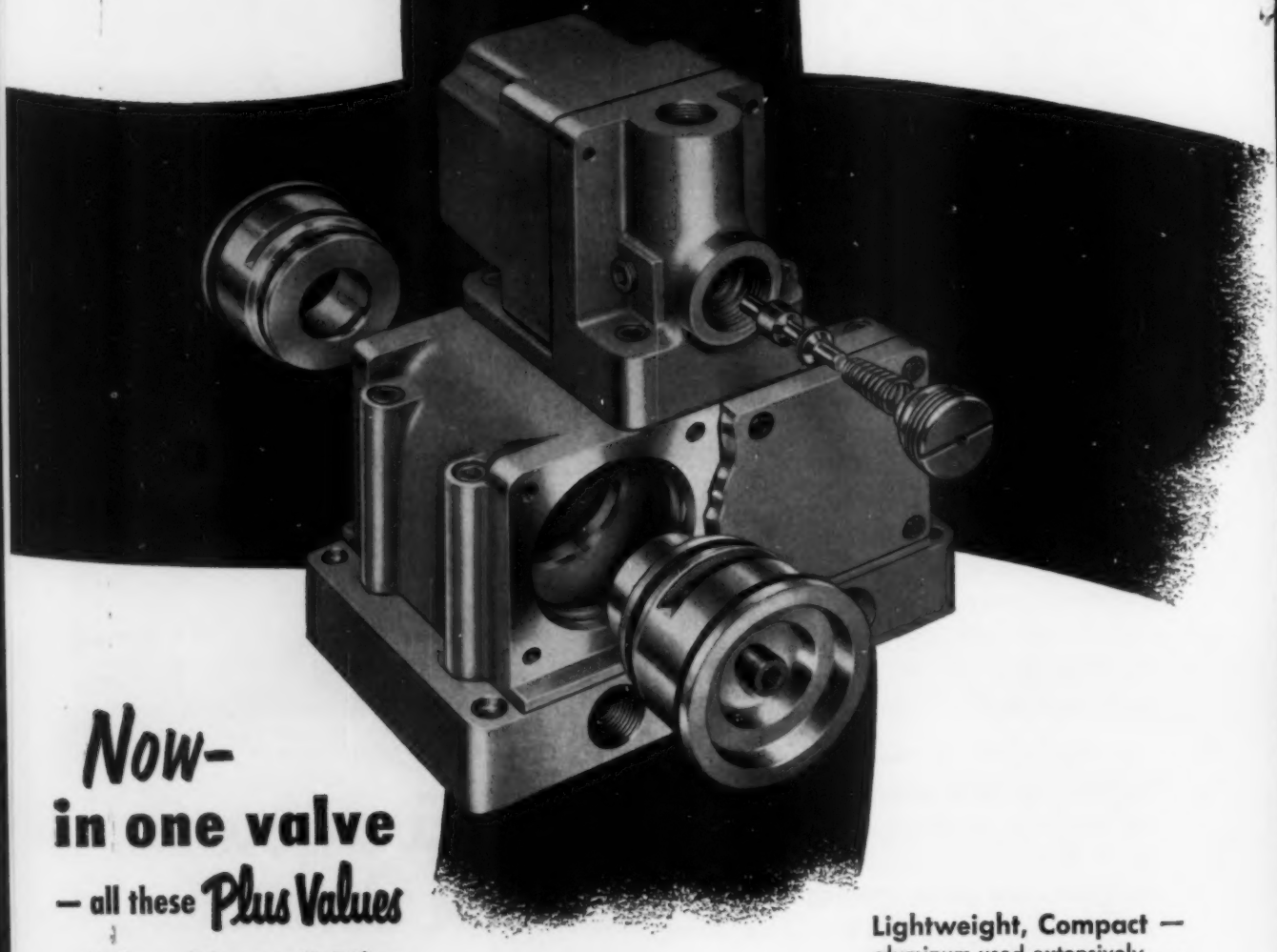
Series 1205 Reset Magnetic Counter with panel mount and lock and key.

Series 1122 Small Reset Ratchet Counter.



Special Longitude Counter, one of many made for aircraft navigational equipment.

Now – Plus Values for you . . .



Now– in one valve – all these Plus Values

"Flow-Director" Pilot Head—simplifies piping and makes desired operation possible simply by piping to the proper port.

Interchangeable Pilot Heads — any pilot head fits any valve, regardless of type or size.

Replaceable Seats, Self-Cleaning—fast and inexpensive replacement of all seats. Poppets do not seat in valve body.

Solenoids — are low amperage, continuously rated industrial type.

High Speed Operation — short stroke solenoid and poppet give split second response.

Full Flow—all passages oversized for minimum pressure drop through valve.

No Springs—piston-poppets shift with air pressure.

Lightweight, Compact — aluminum used extensively . . . smaller over-all dimensions.

Corrosion Resistant — all materials corrosion resistant.

100% J.I.C. Conformance

- subplate mounted
- splash- and dust-proof solenoid covers
- solenoids inoperative with covers removed
- manual push buttons
- covers chained to valve
- *Dryseal* pipe threads

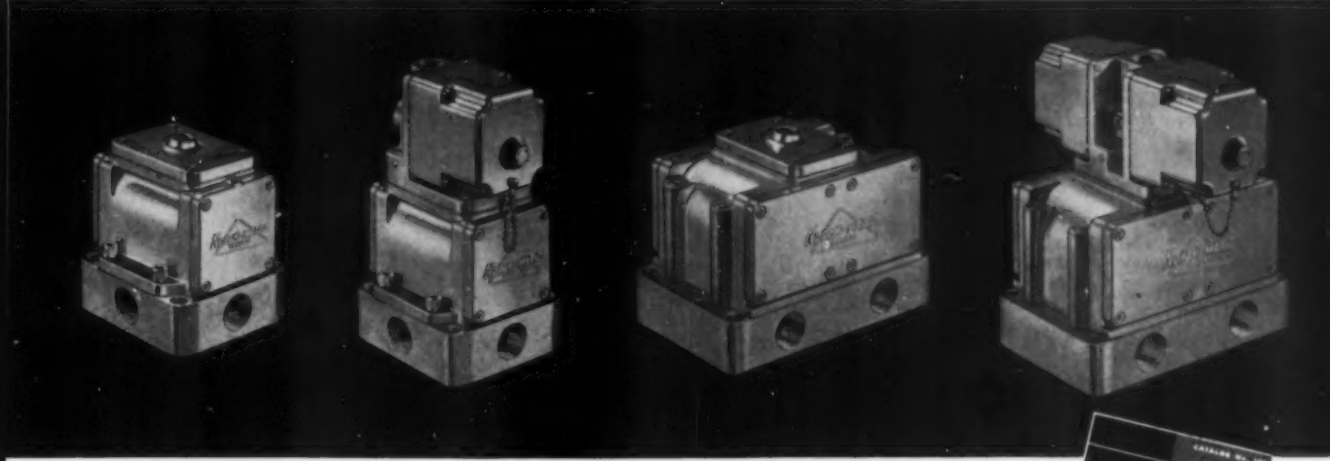
in the new *NOPAK-MATIC* poppet-type air control valves

100% J.I.C. — a complete line of poppet-type, snap-action, air control valves that comply in every detail to J. I. C. Standards . . . and *at no extra cost!*

Simplified Piping — exclusive "Flow-Director" pilot heads allow piping with fewer fittings . . . makes fewer valves adaptable to more applications.

Off 'n On In Less Than 2 Minutes — millions of trouble-free operations are assured but should maintenance be necessary, a complete valve assembly can be replaced in less than 2 minutes . . . piping is never disturbed.

3 Pilot Heads Fit All Models — all pilot heads (master, single or double solenoid) are interchangeable on all valves, regardless of type or size.



NOPAK-MATIC Valves are available in ¼" through ¾" pipe sizes for 2- or 3-Way Normally Open or Normally Closed and 4-Way operation. All valves can be operated with master (air), single solenoid or double solenoid pilot heads. Solenoids are available for all standard A.C. and D.C. voltages. Four-Way valves are available with side or bottom porting.

CATALOG NO. 105 — describes and illustrates all the Nopak-matic Plus Values and gives complete dimension, installation and parts data. Write for catalog 105 now. It will be mailed promptly.

NOPAK *VALVES and CYLINDERS*

GALLAND-HENNING NOPAK DIVISION, 2762 S. 31st St., Milwaukee 46, Wisconsin

by Carl F. Joseph
Technical Director

CENTRAL FOUNDRY DIVISION
GENERAL MOTORS
CORPORATION

.....The metallurgy of strength and

The secret of a stronger iron casting lies in the composition, the melting and the heat-treating processes. Perhaps I should use some other word than "secret," because the fact is well known today, but in 1925, when we started our search for a stronger iron, the principle was well known only in respect to steel.

Our research led us to think that heat-treating could improve iron as well. After considerable experimentation, we learned how to arrest the malleablizing process to produce an improved pearlitic malleable iron . . . an iron that compares favorably with the properties of a good grade forged steel. It is from the words "Arrested Malleable iron with Steel-like characteristics" that the name "ArmaSteel" was coined.

The raw materials and melting process for ArmaSteel are very similar to those of our malleable iron . . . the major difference being in the heat-treat cycle. In the cupola, we melt steel scrap, ferrosilicon, and remelt. We add .0025% boron to the charge to assist in breaking down carbides during malleablizing.

Next, the molten iron is tapped into a forehearth where it is desulphurized with soda ash. This removes small particles of slag and impurities, thus improving machinability of the casting. After refining in an electric furnace, the iron is tapped into ladles.

To improve the physical properties on certain castings, .007% bismuth is added as a ladle inoculant: this stabilizes the carbides during the initial freezing of the metal. On heavy castings such as the Pontiac crankshaft, up to .02% bismuth is added. This bismuth-boron combination is a new development.

I mentioned before that the heat-treating of ArmaSteel greatly affected its properties. Actually, we use several different heat-treatments to produce the several ranges of ArmaSteel. All are alike during the malleablizing cycle, where the massive carbides are eliminated. Malleablizing requires about 20 hours: the castings are held at 1750°F. for 10 hours, and near the end of the cycle are dropped to 1650°F., after which they are air-quenched. Brinell hardness at this point is around 300.

Tempering brings the Brinell hardness down to customer's specifications. We produce two standard Brinell ranges of air-quenched and tempered ArmaSteel . . . BHN 197 to 241 (3.9-4.3 mm.), and 163 to 207 (4.2-4.7 mm.). The castings are tempered in a recirculating furnace. The harder material is in the furnace for a total of six hours and forty minutes, and is held at heat for three and one half to four hours at 1270° to 1290°F. The softer material uses the same time cycle but higher heat . . . from 1320° to 1340°F.

For automobile crankshafts, a special hardness range is used. The ArmaSteel is air-quenched and tempered, but the tempering is for six hours at 1200°F., which produces a harder material (BHN 217 to 269).

Two other types of ArmaSteel are produced by reheating the air-quenched castings to 1600°, holding at heat for thirty minutes, then oil-quenching. These are then tempered for three and one half hours at 1170° to 1190°F. BHN is 241 to 260 (3.7-3.9 mm.) and 269 to 302 (3.5-3.7 mm.).

I've gone into detail on heat-treating because it has such a great effect on mechanical properties. Tempering directly controls the amount of combined carbon in the matrix, and this in turn dictates how hard and strong the ArmaSteel will be . . . the higher the combined carbon, the stronger, harder, and less ductile the casting. Thus, the engineer can choose the combination of properties best suited to his application. I can best explain the results of this careful heat-treatment by giving you a brief list of the mechanical properties of ArmaSteel.

1. *Machinability* . . . Because of the carbon nodules in the pearlite matrix, the machinability of ArmaSteel is generally from 10 to 30 percent better than that of steel forgings of the same Brinell. Improvements of up to ten times longer tool life and three times more pieces per machine have been shown.

2. *Selective Hardening* . . . ArmaSteel responds readily to localized hardening, either by flame or induction methods. A minimum of Rockwell "C" 50 is obtainable on such parts as shifter yokes, rocker arms, and gears. Some applications use the lead immersion or hot salt bath methods, followed by an oil-quench.

3. *Bearing Properties* . . . ArmaSteel is such an efficient bearing material on a hardened steel shaft that bronze bushings are often eliminated. The automotive rocker arm illustrates this excellent non-seizing property in metal-to-metal wear.

4. *High Yield Ratio* . . . The oil-quenched and tempered ArmaSteel has a minimum yield strength of 80,000 psi and ultimate strength of 100,000 psi, making it ideal for highly stressed parts.

5. *Fine Machine Finish* . . . A mirror-like finish can be produced on ArmaSteel. Diesel pistons are an application where this fine finish reduces friction wear to a minimum.

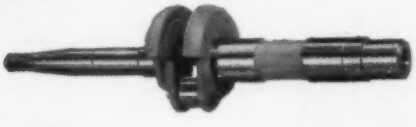
6. *Damping Characteristics* . . . In both small engines and in automotive engines, ArmaSteel crankshafts exhibit a fine damping capacity that aids quiet operation.

7. *Wear Resistance* . . . ArmaSteel withstands excessive wear under heavy loads at high speed.

8. *Fatigue Life* . . . ArmaSteel has good resistance to fatigue, giving maximum endurance and long life.

As countless and varied applications have proven, ArmaSteel is an outstanding engineering material. For information on how your product can benefit from this modern casting metal, write for our "ArmaSteel" catalog.

ARMASTEEL® from the standpoint of machinability

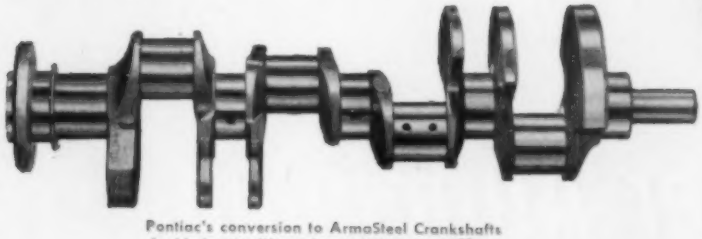


ArmaSteel small horsepower engine crankshafts provide good damping qualities and modest cost due to excellent machinability.

ArmaSteel's adaptability to localized hardening pays off especially well on these automotive rocker arms.

Universal joint yokes of ArmaSteel stand up under severe stresses to same extent as former SAE 1145 or 1151 forgings.

Because of its excellent wear resistance, oil-quenched and tempered ArmaSteel with a Brinell of 241 to 269 has replaced an SAE steel forging for this automotive reverse internal gear.



Pontiac's conversion to ArmaSteel Crankshafts doubled cutter life and speeded up by 50% the grinding of main journals.

CENTRAL FOUNDRY DIVISION

GENERAL MOTORS CORPORATION • SAGINAW, MICHIGAN • DEPT. 10

They add up!...

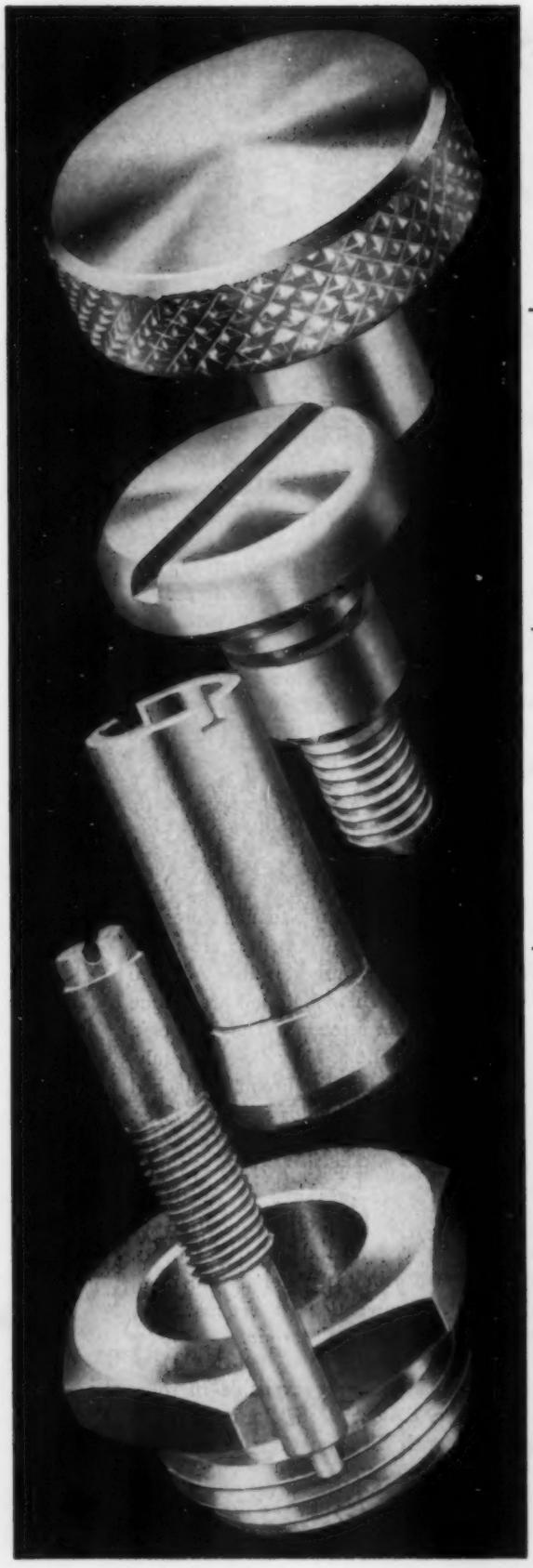
the savings made by converting these five screw machine parts from brass to Kaiser Aluminum add up to $7,720.00 a year for Minneapolis-Honeywell Regulator Company...All five parts run at maximum efficient speed on present machines with little or no change in tooling or equipment...Result?—Minneapolis-Honeywell is now studying further conversions...If you buy or design screw machine parts, why not let a Kaiser Aluminum engineer help you get savings like these in...

Kaiser Aluminum

For complete information and expert assistance, call one of our many distributors, or look for our local number in your classified telephone directory.

Kaiser Aluminum & Chemical Sales, Inc., *General Sales Office*, Palmolive Bldg., Chicago 11, Illinois; *Executive Office*, Kaiser Bldg., Oakland 12, Calif.

>>> "THE KAISER ALUMINUM HOUR." Alternate Tuesdays, NBC Network. Consult your local TV listing.



Adjusting Knob
for Room Thermostat

Cost per 1,000 parts:

Brass	$16.10
Aluminum	9.44
Savings	$ 6.66
Percent Savings	41.3%

Cover Screw
for "Protecto Relay" Unit

Cost per 1,000 parts:

Brass	$16.80
Aluminum	10.80
Savings	$ 6.00
Percent Savings	35.7%

Tension Nut
for "Immersion Aquastat"

Cost per 1,000 parts:

Brass	$9.10
Aluminum	4.50
Savings	$4.60
Percent Savings	50.5%

Adjusting Screw
for "Immersion Aquastat"

Cost per 1,000 parts:

Brass	$11.90
Aluminum	7.33
Savings	$ 4.57
Percent Savings	38.5%

Packing Nut
for Temperature Controller Unit

Cost per 1,000 parts:

Brass	$33.60
Aluminum	21.45
Savings	$12.15
Percent Savings	36.2%

Recommended by Managements

Specified by Designers

Preferred by Operators

New Accopac materials useful range of

Expanded fiber sheet gasket line now includes radically different asbestos materials – offers high sealing efficiency at flange pressures of 10,000 psi or more and temperatures to 500° F.

The new, expanded line of Accopac® materials brings an entirely new degree of sealing efficiency to fiber sheet packings. Where plant fiber gaskets are called for, Accopac offers dimensional stability and improved dependability. For applications where compressed asbestos materials are now specified, the new, flexible Accopac asbestos compositions offer easier handling and lower cost along with excellent sealing characteristics.

For flange pressures from 800 – 2,000 psi

Applications in this range of flange pressures usually require gaskets with relatively high compressibility. To meet this need, Accopac materials made of cellulose fiber, ground cork, and synthetic rubber binders are available. These materials need relatively light bolt pressures to seal normal joints. They conform to the surface irregularities commonly found in lightweight stampings and castings. These Accopac materials are recommended where temperatures do not exceed 250° F. Materials in this class are designated as CS-301 and CN-705.

For flange pressures over 2,000 psi

For heavy-duty flanges where bolt pressures are 2,000 psi or higher, there are Accopac materials that contain no cork. These are dense formulations designed to take heavy loads with minimum loss of bolt torque. Where temperatures do not exceed 250° F., they offer an economical replacement for compressed asbestos sheet packing. Compositions included in this group are N-820, N-852, N-854, and D-856.

For high-temperature applications

For sealing jobs where flange temperatures are up to 500° F. and internal pressures are up to 500 psi, a group of new asbestos-fiber Accopac materials is available. These materials are unique among asbestos gasket materials. They're tough, flexible, and easy to handle. They die-cut cleanly, and there are no loose fibers to become detached and contaminate contained fluids or clog orifices.

Accopac asbestos compositions AS-428 and AN-859 seal at flange pressures of 2,000 psi, somewhat lower than the pressure required for the general run compressed asbestos sheets. Although Accopac asbestos materials are more compressible than conventional sheet materials, they maintain the desired bolt torque.

All Accopac materials are available in rolls, sheets, ribbons, or die-cut pieces. For more information, get in touch with your Armstrong representative. Or write direct.

greatly extend fiber sheet gaskets

WHY ACCOPAC MATERIALS SEAL EFFICIENTLY

All Accopac materials are made by a patented modification of the beater saturation process in which individual fibers are coated with a synthetic latex binder before the sheet is formed.

This process assures uniform distribution of fibers and binder. The result is a strong, homogeneous sheet. Even in very thin gauges, Accopac materials are tough and flexible.

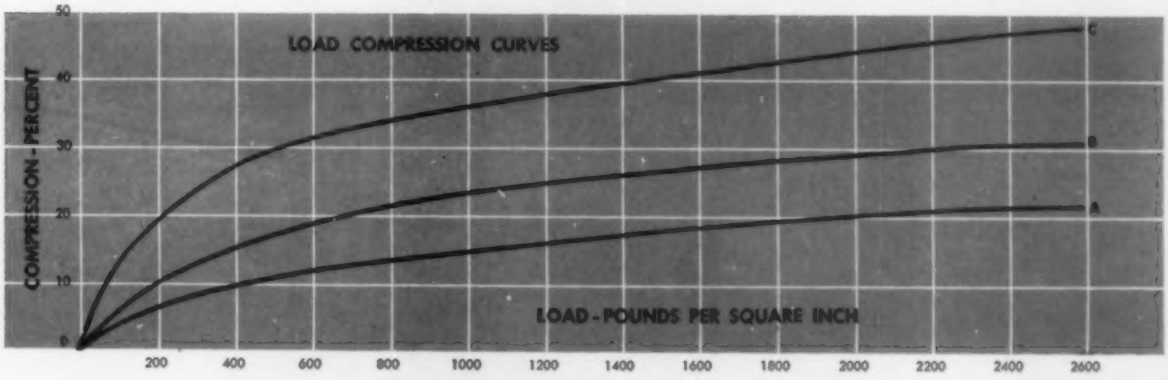
The synthetic latex binder in Accopac compounds is non-volatile and non-extractable. It cannot be leached out by the action of contained fluids or be vaporized by heat, as often happens with conventional glue-glycerine sheets. Even in alternately wet-and-dry applications, the Accopac binder-fiber structure remains intact.

To provide resistance against a wide variety of oils, solvents, chemicals, and gases, the Accopac line offers a choice of synthetic latex binders. For example, for certain oil and all water services, the styrene-type (Buna S) binder is usually recommended; for oil, gasoline, and other aromatic fuels, the nitrile-type (Buna N) binder is generally suitable, although the chloroprene-type (neoprene) is preferred by some.

Accopac Cellulose-and-Asbestos Fiber Gasket Materials

Type	Composition	Curve	Tensile Strength (Minimum) AMD	Percent Compressibility* (1000 psi)
CS-301	cellulose fiber, cork, and synthetic rubber (styrene type)	C	800	30-45
CN-705	cellulose fiber, cork, and synthetic rubber (nitrile type)	C	1000	30-45
N-820	cellulose fiber and nitrile-type rubber	A	3000	10-20
N-852	cellulose fiber and blend of synthetic rubber	B	1800	17-27
N-854	cellulose fiber, mineral filler and nitrile-type rubber	B	2500	15-25
D-856	cellulose fiber and chloroprene-type rubber	B	2000	17-27
AS-428	asbestos, styrene-type synthetic rubber	B	1200	17-27 (1000 psi)
AD-838	asbestos chloroprene-type synthetic rubber	B	1200	30-40 (5000 psi)
AN-859	asbestos nitrile-type synthetic rubber	B	1700	

*Tested per ASTM D-1147-53T

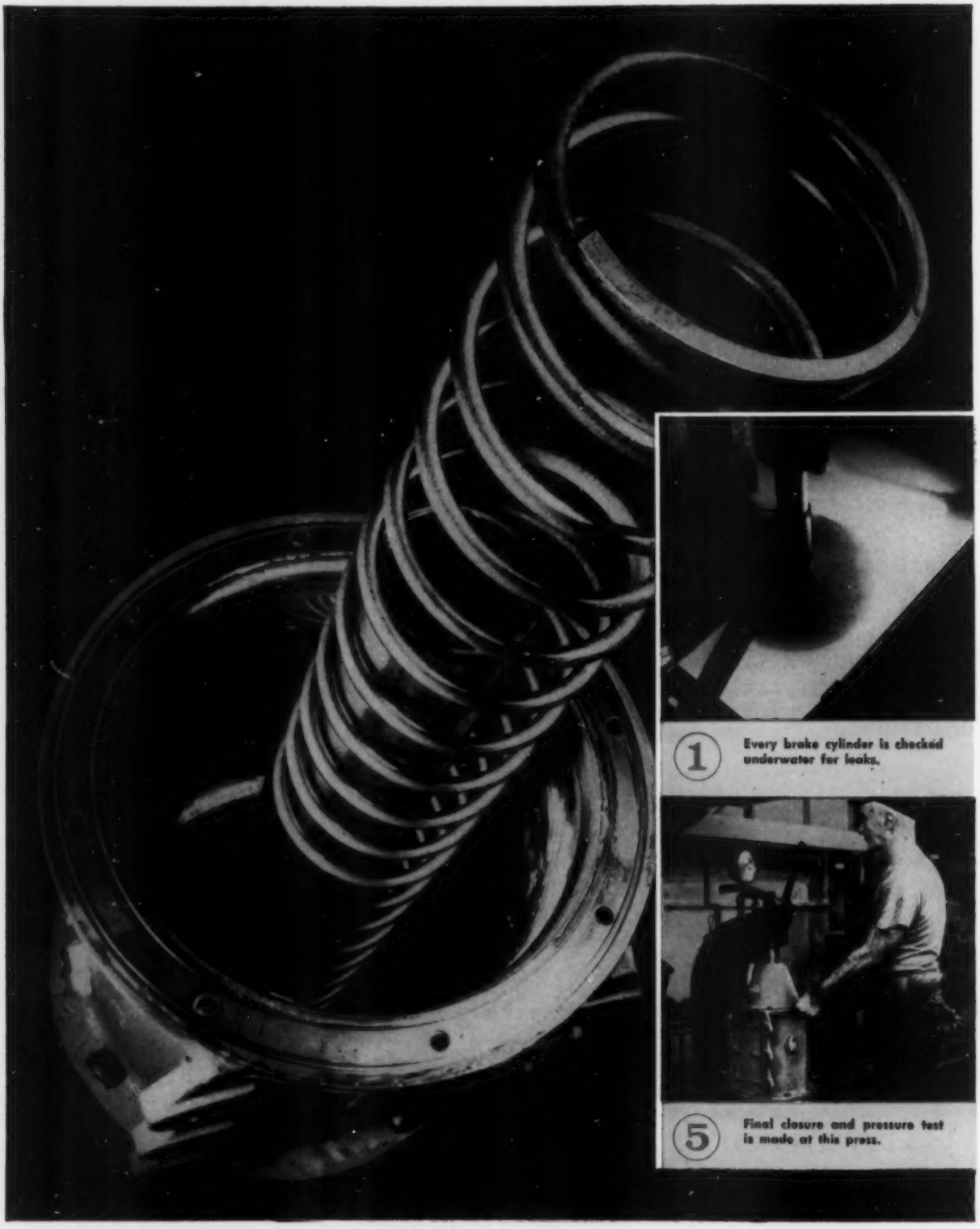


Armstrong ACCOPAC

. . . used wherever performance counts

You'll find more helpful information on the whole line of Accopac fiber sheet gasket materials in this new folder. Write for your copy today. Address Armstrong Cork Company, Industrial Division, 7003 Irvin St., Lancaster, Pa.

Inside story of the most



1 Every brake cylinder is checked underwater for leaks.

5 Final closure and pressure test is made at this press.

famous brake in the world

Even schoolboys know the fabulous story of George Westinghouse, and how he accelerated developments of railroad transportation with his Westinghouse Automatic Air Brake. Even if a train breaks in two, brakes are applied to *each* section to stop it.

Although Westinghouse Air Brake Company has made countless improvements in braking devices, the basic operating principles have prevailed since 1872. Original design of some parts is still followed today, that's how well they were designed in the first place.

A good example is the release spring, which retracts the brake cylinder piston when the brakes are released. American Steel & Wire has been supplying this spring for about 75 years. And although better steels and heat treatment are always being used, this original spring design has been operating over a 160° F. temperature range, stressed hundreds of times monthly, and is currently in service on over 2 *million* freight cars all over the world.

We are proud of our long association with Westinghouse Air Brake Company, maker of the most famous brake in the world, considered by many people to be one of the great inventions of our time.

AMERICAN STEEL & WIRE DIVISION, UNITED STATES STEEL, GENERAL OFFICES: CLEVELAND, OHIO
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA., SOUTHERN DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS AMERICAN QUALITY SPRINGS

2 Piston assembly. Westinghouse Air Brake Company makes its own rubber parts.

3 After piston is inserted, workman lubricates the cylinder.

4 Spring inserting. The housing is machined high-density cast iron.

6 Cylinder at left is for freight cars, other is one of several used on a locomotive.

7 In position. Cylinders go three years between cleanings.

USS

UNITED STATES STEEL

Designed for Strength and Safety

STRENGTH AND SAFETY are built-in features of this seat-belt buckle made from Republic Stainless Steel, Type 201. Fabricating operations include: shearing into blanks of .125 thickness, punching, a severe bend of 175° to form the hook.

SAFETY ASSURED by designing the high strength advantage of stainless steel into the simple beak-type buckle. No intricate springs or mechanisms to fail at the wrong moment. Both belt and buckle are rated 1000 pounds in excess of CAA specifications.

REPUBLIC

REPUBLIC STEEL

World's Widest Range of Standard Steels

with STAINLESS STEEL

SEAT-BELT MANUFACTURER LICKS CRITICAL PROBLEM WITH REPUBLIC ENDURO, TYPE 201

Here are the facts on a new and cost-cutting use of Republic ENDURO® Stainless Steel, Type 201, by Bunke-Musser Company, Jackson Center, Ohio, manufacturers of safety seat-belts for the automotive industry.

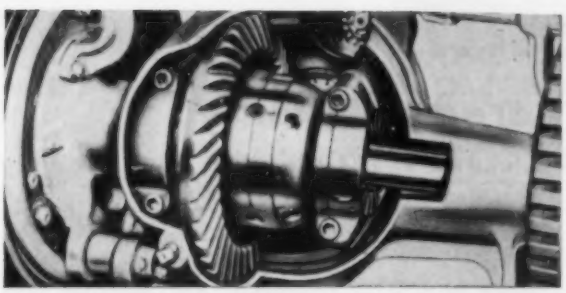
The most critical part of the entire assembly is the buckle. It must conform to Associated Seat Belt Manufacturers' specifications. These require that the buckles be subjected to a test pull of 1500 lbs., then reduced to 125 lbs. At this point, the pelican hook of the buckle must be capable of release at 45 lbs. pressure.

Prior to adoption of Type 201, another grade of stainless had been used. However, the slightly softer surface of this type resulted in a galling action at the fulcrum of the buckle when the release pressure was applied.

Bunke-Musser also experimented with carbon steel. But this required use of heavier gage, chrome plating and polishing, with the end result being much more expensive than stainless steel.

Now the company has standardized on Republic, Type 201, with excellent results. The buckles meet and exceed test specifications. The galling action has been eliminated. Tensile strength increased 200 lbs.

Types 201 and 202 are relatively new members of Republic's family of stainless steels. Republic Specialists will be happy to work with you in designing these new grades into your product. The 200 Series offers high strength, corrosion-resistance and easy forming on your present equipment. And they are readily available. Mail the coupon for more information, or if you would like a Republic Specialist to call at your plant. There's no obligation.



THERE'S NO SACRIFICE OF STRENGTH OR SAFETY in this drive axle designed from Republic Alloy Steel. In these fine steels you will find the highest strength values—plus an exceptionally high strength-to-weight ratio that permits transmission of hundreds of horsepower through tough, strong axles, shafts and gears, free from excess weight. Republic Alloy Steels are essential in designing smaller sections to carry heavier loads safely—essential in extending equipment life and reducing maintenance and replacement costs. Send coupon for data.

A BUILT-IN SAFETY FACTOR is one reason why Republic Nylok Nuts are being used in thousands of critical applications to resist shock, vibration and cyclic loading. The answer is in the nylon plug in one face of the nut which forces threads on other side tight against bolt or stud. Above, Nylok Nuts provide a powerful clamp action and keep vital steering tie-rod assembly securely in adjustment. Nylok Nuts can be removed for maintenance of parts, then re-used with no loss in holding power. And because either end is up they are ideal for automatic feeding and power wrenching. Send coupon for more facts.

STEEL

and Steel Products

REPUBLIC STEEL CORPORATION
Dept. C-2865,
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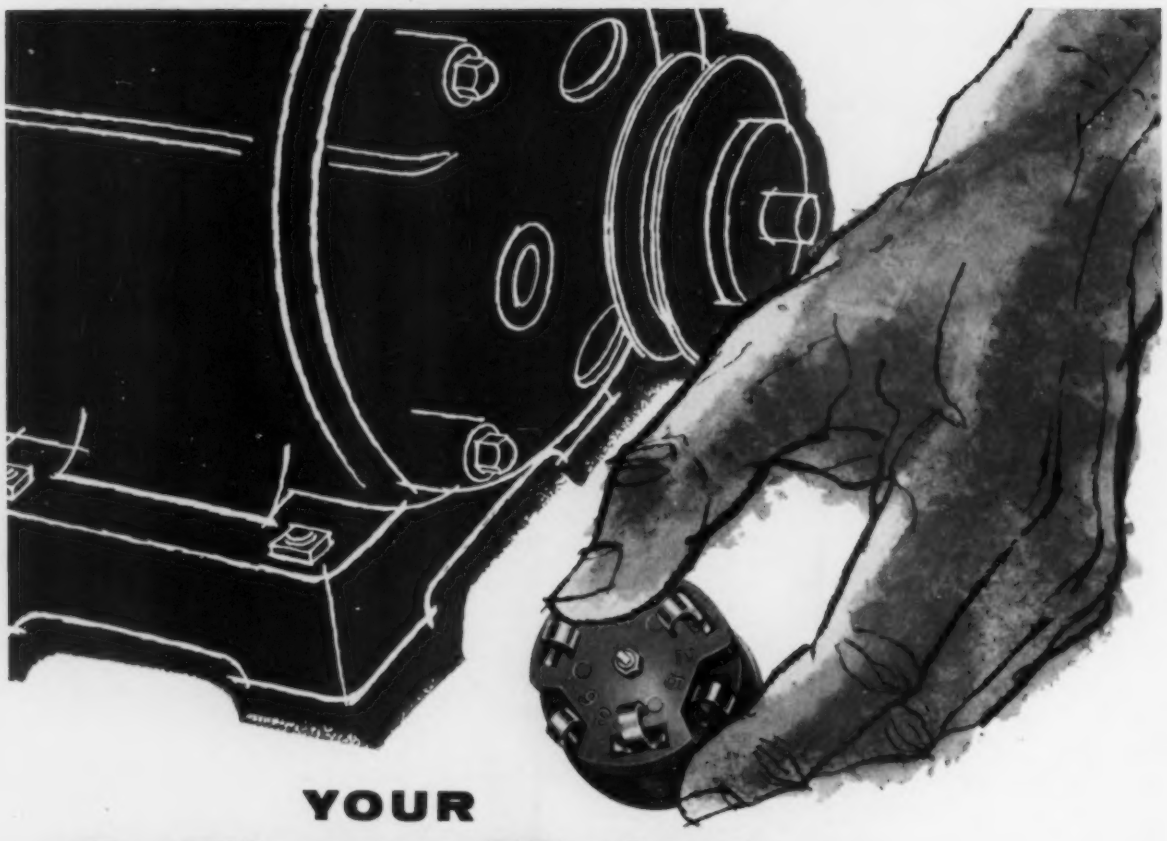
☐ Please have a Republic Specialist call.
Send more information on:
☐ 200 Series Stainless Steel ☐ Alloy Steels ☐ Nylok Nuts

Name _____ Title _____

Company _____

Address _____

City _____ Zone ____ State _____



YOUR 3-Phase Motor

can now have full engineered protection with a single, built-in KLIXON Protector

PREVENT OVERHEATING CAUSED BY:

- **Prolonged overloads**
- **Single phasing**
- **Stalling**
- **Failure to start**
- **Lack of ventilation**
- **Increase in ambient temperature**
- **Plugging or reversing duty**
- **Unbalanced voltage**

Now your 3-phase Motors can have the same protection that motor manufacturers have for years engineered into single-phase motors. That's because Motor manufacturers everywhere can supply standard three-phase motors with built-in Klixon Protectors.

The result: you're assured of maximum work output with minimum down time.

Klixon 3-phase Protectors are now available for Motors ranging from fractional HP up to 7½ HP (600V).

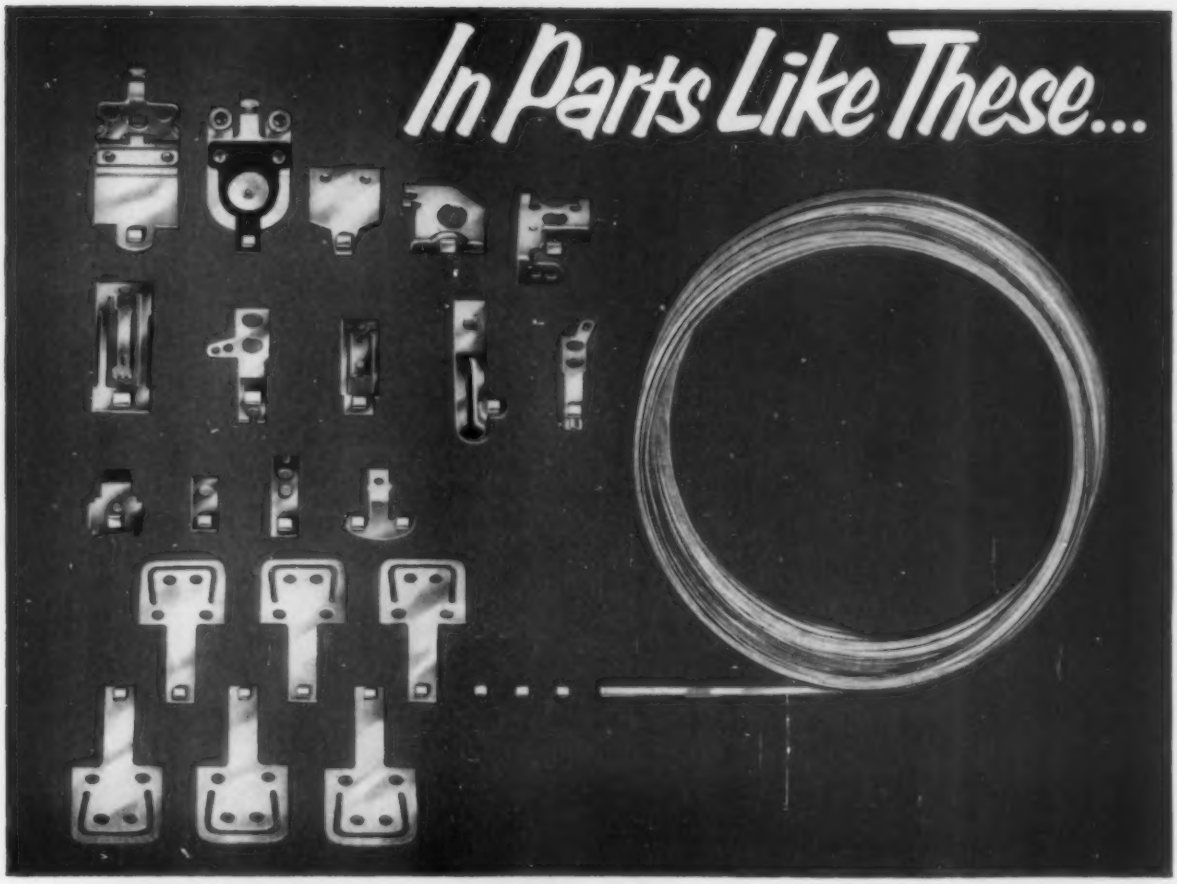
BUILT-IN KLIXON AUTOMATIC AND MANUAL RESET PROTECTORS FOR 3-PHASE MOTORS:

- Reduce production down time
- Eliminate motor burnouts
- Minimize motor repairs and replacements
- Assure maximum motor capacity under any conditions
- Simplify motor controls

Specify and use
MOTORS WITH BUILT-IN KLIXON PROTECTORS

Get the details from your district motor salesman . . . then specify and use motors with Klixon Inherent Protectors. The additional cost is low . . . the savings high . . . the advantages really worth-while!

METALS & CONTROLS CORPORATION
Spencer Thermostat Division
3803 Forest Street, Attleboro, Mass.
KLIXON



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The contact face is available in practically any ductile contact material either as a single metal or clad to another metal. Contact backing or supporting materials are available in steel, brass, copper, phosphor bronze, beryllium copper, nickel or monel, and aluminum.

Why not find out how you can benefit with General Plate Clad Electrical Contact Tapes? Write for complete information, or better still, ask for a General Plate Engineer, who will gladly help you with your contact problems.

You can profit by using General Plate Composite Metals!

METALS & CONTROLS CORPORATION
GENERAL PLATE DIVISION
1003 FOREST STREET, ATTLEBORO, MASSACHUSETTS

See what adhesives are doing today!

WHEN THIS MAN SQUEEZES THE TRIGGER, HE CUTS PRODUCTION COSTS. HIS SPRAY GUN IS LOADED WITH A MODERN ADHESIVE BY 3M.

Shooting holes in production costs

Every day this worker shoots holes in his company's manufacturing costs. The 3M adhesive in his spray gun creates a structural sandwich that's inexpensive, featherweight and strong. *Naturally this adhesive is a favorite with the comptroller.*

3M adhesives like EC-1357 and EC-1177 bond a honeycomb paper core between thin metal skins. They produce rigid, more durable units from such light materials because they're tougher, more flexible. Many industries benefit: building, furniture, aircraft, railroad equipment and others.

These 3M adhesives are specially designed for this sandwich construction, thoroughly tested. They apply fast and easily, like the hundreds of varied 3M adhesives for other uses.

SEE WHAT ADHESIVES CAN DO FOR YOU! Consult 3M research. Contact your 3M Field Engineer. Or for information and free literature write on your company letterhead to: 3M, Dept. 73, 417 Piquette Avenue, Detroit 2, Michigan.

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Winners in dozens of new and improved products... the versatile, controllable new urethane foams made from National Nacconates! They insulate! They absorb shock and sound! They cushion in downy comfort! In rigid form they provide structural support! And urethane foams are lighter, stronger and age better than traditional foams.

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No wonder urethane foams are turned to new uses every day... in upholstery, crash pads, packaging, apparel linings, quilted coverlets, washable toys, boat hulls, aircraft wings and radomes!

It's time now to investigate what urethanes can do for your business. For further information, write National today!

URETHANE FOAMS
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Vibration won't loosen FLEXLOC self-locking nuts

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HERE'S WHY:

FLEXLOC locknuts are strong: tensile strengths far exceed accepted standards. They are uniform: carefully manufactured to assure accurate, lasting locking action. And they are reusable: repeated removal and replacement, frequent adjustments, even rough screw threads will not affect their locking life.

Standard FLEXLOC self-locking locknuts are available in a wide range of standard sizes, types and materials to meet the most critical locknut requirements. Your local industrial distributor stocks them. Write us for complete catalog and technical data. Flexloc Locknut Division, STANDARD PRESSED STEEL CO., Jenkintown 28, Pa.

FLEXLOC® LOCKNUT DIVISION

STANDARD PRESSED STEEL CO.

SPS

JENKINTOWN PENNSYLVANIA

GOLD-N-RING ... a new name and a new conception of CONTROL SWITCH design

HEAVY-DUTY

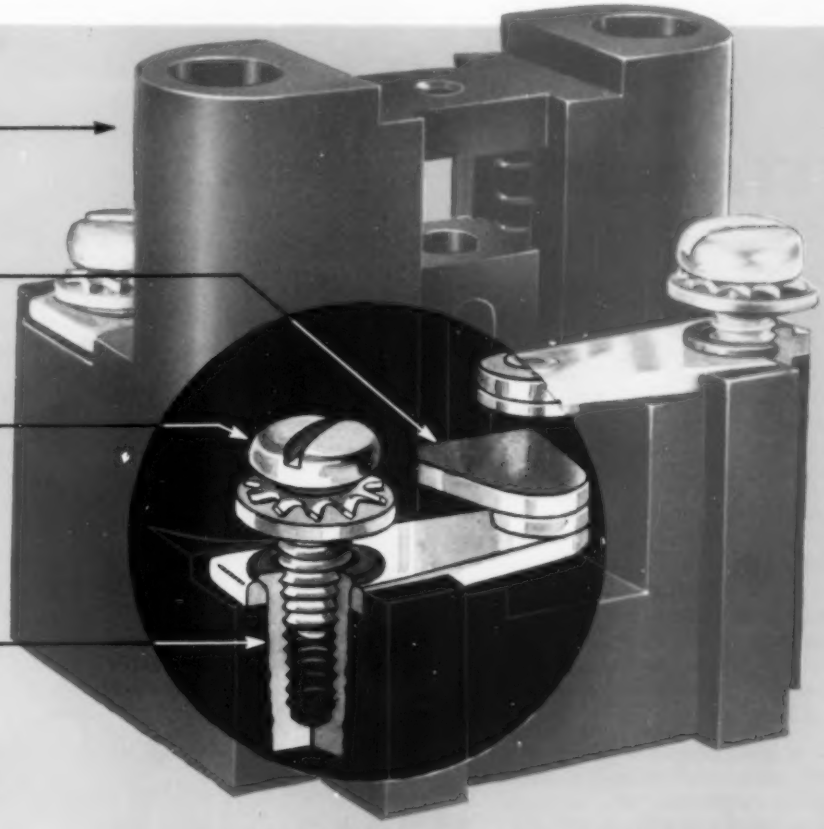
OIL-TIGHT—WATER-TIGHT—DUST-TIGHT

made by machine tool builders to machine tool specifications

A new name—GOLD-N-RING Sealtight Control Switch! A new conception—a control switch *designed and built BY a manufacturer of machine tools—FOR machine tool builders!*

A product of the same machine tool background responsible for Namco Solenoids and Snap-Lock Limit Switches, it gives designers a *package of greater electrical efficiency*—available from a single source, with a single source responsibility.

Shown here are only a few of many reasons why the GOLD-N-RING Control Switch makes it possible to match machine tool mechanical ruggedness with equally durable electrical efficiency.



1. **MAIN BLOCK** is unit-molded to assure alignment and simplify assembly.

2. **HEAVY-DUTY SILVER-ALLOY CONTACT POINTS** for maximum electrical capacity and long life.

3. **HEAVY-DUTY TERMINAL SCREWS**, with ⅜" thread contact, prevent stripping during installation; permanently secure wires for continuous trouble-free service.

4. **BRASS INSERTS MOLDED IN THE BLOCK** permanently hold stationary contacts. They also provide more thread support for the No. 8-32 terminal screws that are equipped with captive flat and lock type washers.

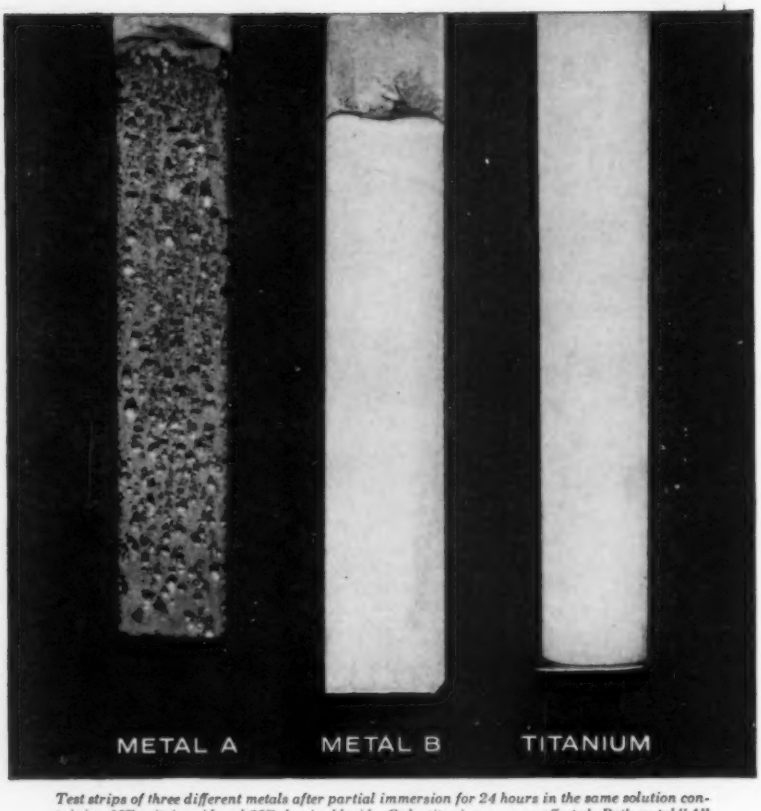
For complete details, send for Bulletin EC3-56. Better yet, ask for a representative to bring a switch for your examination.

ELECTRICAL MANUFACTURING DIVISION

National Acme

THE NATIONAL ACME COMPANY • 170 EAST 131ST STREET • CLEVELAND 8, OHIO

Progress with **TITANIUM**



Test strips of three different metals after partial immersion for 24 hours in the same solution containing 10% nitric acid and 20% ferric chloride. Only titanium was unaffected. Both metal "A" and "B" are commonly used in corrosive processing applications.

TITANIUM

...the lowest cost material of construction?

• Although known as a high-priced metal, titanium is actually the lowest-cost material available in a surprising number of applications. For titanium has exceptional resistance to many corrosive media that severely attack other specialty metals.

To evaluate the economies of titanium try it where you have severe corrosion problems. Test and operating data indicate outstanding performance in contact with some of the most troublesome industrial chemicals — nitric acid, moist chlorine, chlorinated organic or inorganic compounds, etc.

As to *original* cost of titanium, per-pound price is not indicative, since titanium weighs only 56% as much as steel. Also, fabrication and other costs of any equipment usually far outweigh the material costs. On the basis of typical processing equipment which has been produced, the use of titanium versus stainless steel increases original cost by a factor of 3. Where there are substantial savings in replacement and down-time, titanium quickly pays for itself. Titanium in several cases has lasted up to 15 times longer than conventional materials.

Let us help you evaluate titanium. It may well be the lowest cost material of construction for your processing equipment. You can obtain Mallory-Sharon titanium and titanium alloys in standard shapes. For booklet on Titanium Corrosion Properties write Dept. P-3.

TYPICAL PRESENT APPLICATIONS OF TITANIUM

Anodizing racks	Impellers
Condenser inserts	Piping
Filters	Process vessels
Heat exchangers	Steam jet diffusers

MALLORY Ti SHARON

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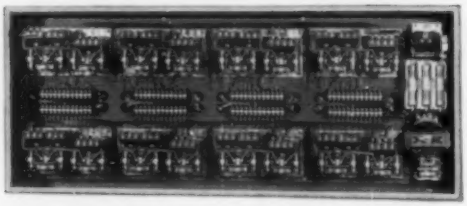
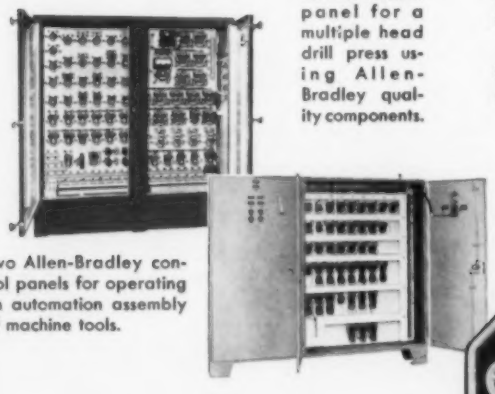
for trouble free operation—

let ALLEN-BRADLEY build your Special Control Panels



Motor control panel for a multiple head drill press using Allen-Bradley quality components.



Two Allen-Bradley control panels for operating an automation assembly of machine tools.

When the control panel furnished with your production machine carries the Allen-Bradley trademark of QUALITY, your customer's approval is assured! That is why so many leading machinery builders have standardized on Allen-Bradley controls. The "simple design" of all Allen-Bradley controls is your guarantee of trouble and maintenance free service.

No matter how complex your control requirements may be, as specialists in this field, Allen-Bradley's experience may be of valuable assistance to you. Call your nearest A-B office.

Allen-Bradley Co., 1316 S. Second St., Milwaukee 4, Wis.
In Canada—Allen-Bradley Canada Ltd., Galt, Ont.

ALLEN-BRADLEY

QUALITY

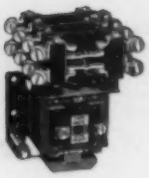
MOTOR CONTROL

A-B Quality

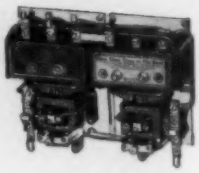
3-57-R

"we'll use ALLEN-BRADLEY Quality Motor Control ...it's trouble free!"

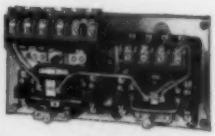
SPECIFY THESE RELIABLE MOTOR CONTROL UNITS



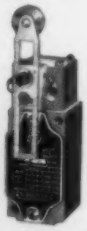
Bulletin 700
Universal Relay with
N.O.—N.C. Contacts



Bulletin 705 Size 2
Reversing Starter

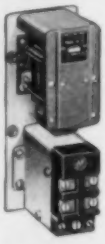


Bulletin 715 Two
Speed Consequent
Pole Starter



Bulletin 802T Adjustable
Lever Oiltight Limit
Switch

Bulletin 702 Three Pole
Size 2 Contactor



Bulletin 849 "On-Delay"
Pneumatic Timer

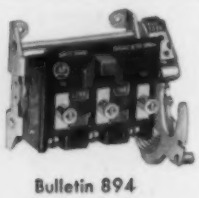
Bulletin 892
Handy Terminal
Blocks

Bulletin 704, Mechanically
Held, Hum-free Relay

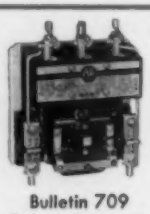
Bulletin 200
D-C Relay

Bulletin 350
Reversing Drum Switch

Bulletin 836
Pressure Control in
NEMA Type 4 Enclosure



Bulletin 894
Visible Blade
Disconnect Switch



Bulletin 709
Size 4 Automatic
Starter

Bulletin 609
Three Phase
Manual Starter

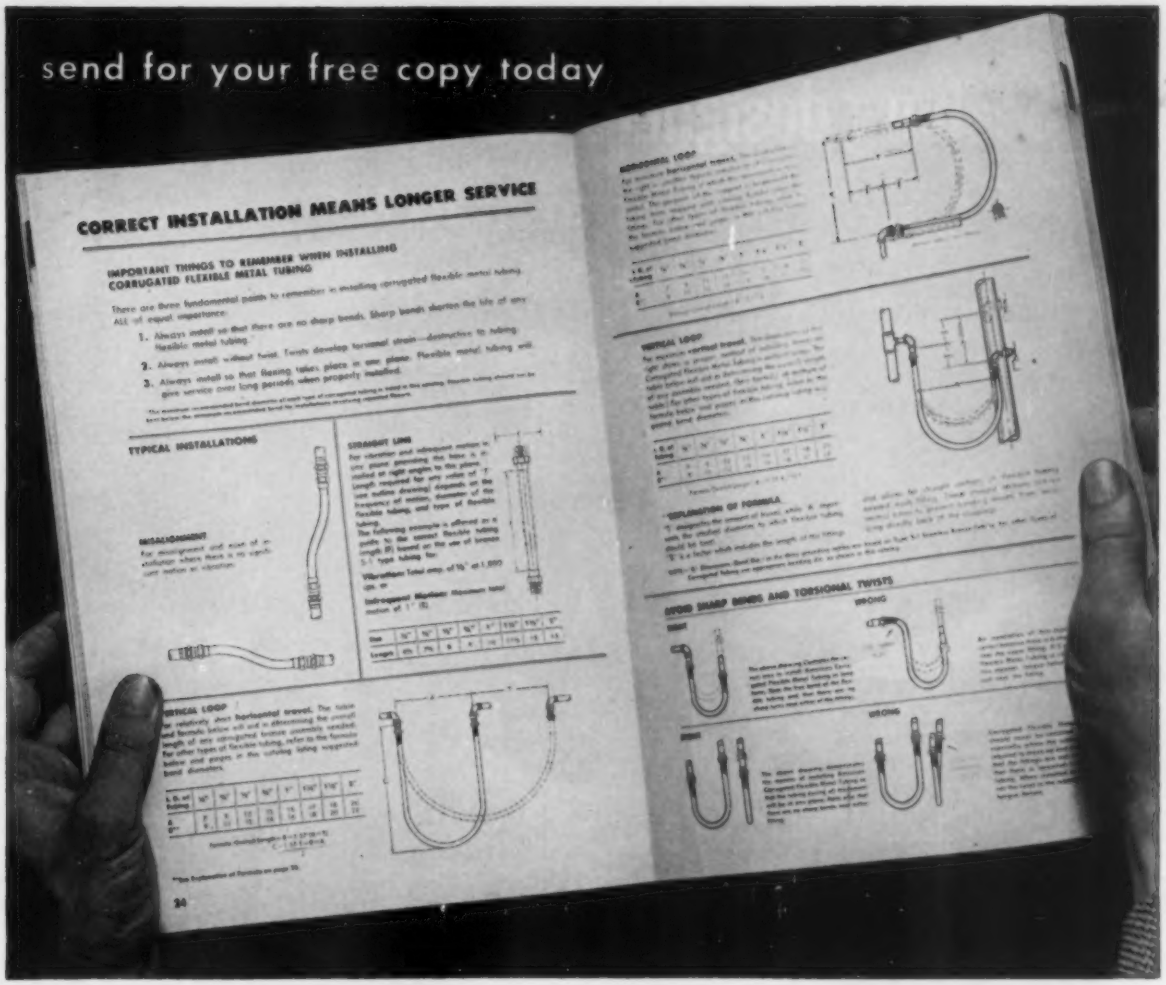
Oiltight Push Button, Selector Switch, Press-to-Test
Pilot Light, and completely assembled Oiltight Station

Allen-Bradley *quality* components assure you millions of trouble free operations. The simple design, maintenance free, double break, silver alloy contacts, and rugged design features have made them the first choice among design engineers, contractors, and maintenance men. You just can't go wrong with this QUALITY line.

Allen-Bradley Co., 1316 S. Second St., Milwaukee 4, Wis.
In Canada—Allen-Bradley Canada Ltd., Galt, Ont.

Send for your copy of the new 7th edition of the Allen-Bradley Handy Catalog

3-57-MR



New catalog simplifies selection and ordering of flexible metal hose and tubing

Here's the most complete, most up-to-date catalog on flexible metal hose available today.

Full description of the two basic types of flexible metal hose: corrugated metal tubing and strip-wound hose. Suggestions on correct installation of flexible metal connectors — specifications, bend diameters, length of tubing needed. Type designations and descriptions of flexible hose and tubing made of brass, bronze, aluminum, stainless steel, steel, Monel. Descriptions of end fittings.

Guide to special flexible metal hoses for special jobs: Vibration Eliminators; Flexpipe* flexible connectors; Presstite† connectors for laundry and garment pressing machines; Bracketubes for steam-heated platen presses; Sealtite* flexible, liquid-tight electrical conduit; tank car unloading hose assemblies; tar and asphalt hose assemblies; insulated hose; exhaust and air intake hoses; flexible lamp arms; shielding conduit; Flexlube* oil feed and coolant lines; and other products for special services.

*Trademark †Reg. U.S. Pat. Off. 56185

WHEREVER CONNECTORS MUST MOVE **AMERICAN**

flexible metal hose and tubing

AN **ANACONDA**® PRODUCT

MAIL COUPON TODAY FOR YOUR FREE FLEXIBLE METAL HOSE AND TUBING CATALOG!

The American Brass Company
American Metal Hose Division
Waterbury 20, Conn.

Gentlemen: Please send me a free copy of your new flexible metal hose and tubing catalog, G-560.

NAME & TITLE.....

COMPANY.....

ADDRESS.....

CITY, ZONE, STATE.....

Seeburg designers choose P-K® screws

to match the fastener to the job!

Joseph Kamys, engineer, J. P. Seeburg Corporation, Chicago, manufacturers of coin operated phonographs says, "Seeburg standards demand attention to every detail—quality workmanship and materials throughout. With Parker-Kalon screws, we can match the fastener to the specific application—be sure of dependable results."

Attachment of metal base molding and kickplate to a Seeburg cabinet, in a metal-to-wood application. "Rather than use ordinary wood screws, we power-drive P-K Self-tapping Type-A," says Mr. Kamys. "Holding power is far better, there's less chance of wood splitting, and fewer rejects at inspection."

Here, metal rims of two high-frequency speakers are fastened to a formed, one-piece, plastic housing. "In this metal-to-plastic application we have not only the problem of possible plastic breakage, but the fastener used must be highly resistant to vibration. We find P-K thread-forming Type-Z screws highly satisfactory."

If you are designing a new product or new model, it will pay you to talk with a Parker-Kalon Field Engineer. He can help in the selection of proper fasteners, can often suggest ways to speed production—cut costs. You can contact him through your local Parker-Kalon Industrial Supply Distributor.

***PARKER-KALON DIVISION,** General American Transportation Corporation, Manufacturers of Self-tapping Screws, Socket Screws, Screwnails, Masonry Nails, Wing Nuts and Thumb Screws.*

Sold Everywhere Through Leading Industrial Distributors. Factory: Clifton, New Jersey—Warehouses: Chicago, Illinois, Los Angeles, Calif.

PARKER-KALON®
fasteners

The only Belt Drive that replaces uncertain friction grip with

POSITIVE TOOTH ENGAGEMENT!

Gilmer

THE ORIGINAL

"TIMING" BELT

Power Transmission Drive

Just look at all the money-saving advantages that stem directly from this unique "Timing"® Belt feature:

There is no belt slippage or creep, therefore:
- Constant angular velocity is transmitted;
- Precision *timing* is maintained between shafts;
- Practically 100% efficiency is obtained;
- Belt and pulleys last much longer.

No initial belt tension is required, therefore:
- Belt's rated horsepower is all *working* horsepower;
- Bearing loads are minimized, and wear reduced;
- Take-up adjustments are eliminated.

Less belt-pulley contact area is needed, therefore:
- Drives can be more compact, take less space;
- Smaller-diameter pulleys can be used;
- Higher drive ratios are practical.

Additionally, the "Timing" Belt drive needs no lubrication. Rating for rating, its cost is usually the lowest...especially when you can take advantage of stock drives.

A factory-trained Power Transmission Field Engineer will gladly help you adapt the "Timing" Belt's many unique advantages to your product's drives—from "fleapower" to over 1,000 horsepower!

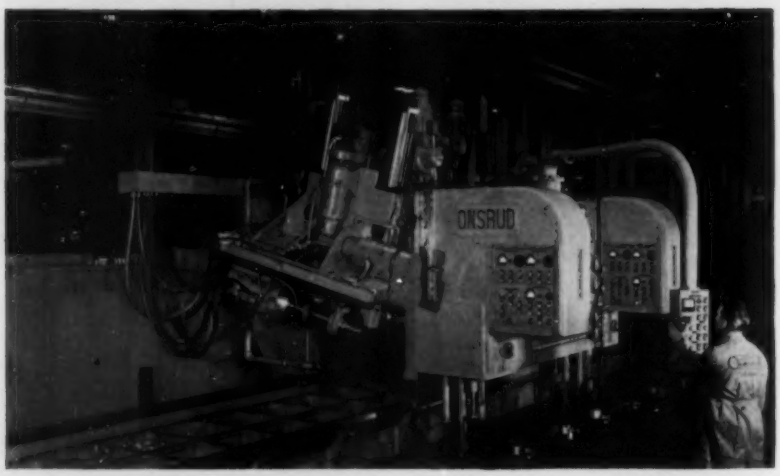
NYB&P

NEW YORK BELTING & PACKING CO. 1 Market St., Passaic, N. J.

America's Oldest Manufacturer of Industrial Rubber Products

Designer's

General Electric tracer control systems meet every machine-tool need, speed production automatically



"A SYSTEM FOR EVERY MACHINE APPLICATION" includes a tracer control system for this 90-ton Onsrud contour milling machine. It directs twelve simultaneous cutter-feed motions, changes them at a rate much faster than possible by human hands, makes repeat cuts to accuracies of 0.002 inch.

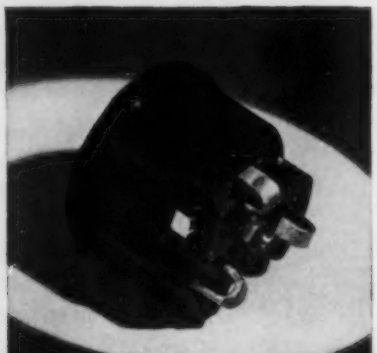
To enable machinery designers to build fast, accurate, consistent production into lathes, milling machines, vertical boring mills and similar machines, General Electric offers a line of electric tracer control systems to operate machine tools. Five different systems can be applied singly or in combination to control any number of motions, in any machine application—automatically.

Basic function in all cases is the same —to direct motions of cutting tool or tools per directions stored in templates. In operation, cutting tool is guided over the work by a tracer head which automatically follows contours of template and controls speed of feed drives.

These completely engineered systems are applied to machines in close co-operation with machinery builders to provide integration of control and machine. For more data, see Bulletin GEA-6122.

Another motor "first"—inherent protection now available on TRI 55 CLAD polyphase motors (1-5 hp)

COMPLETE LINE of Tri-Clad '55' motors includes dripproof motors (shown), totally enclosed motors, and a full line of industry specified types. Many motors accessories are also available.



INHERENT PROTECTION—latest Tri-Clad '55' extra-value feature—responds to current and temperature, helps protect motor from overloads, stalls, and high ambient temperatures.

For the first time in the motor industry, built-in thermal protection is now available on General Electric's line of Tri-Clad* '55' foot-mounted, drip-proof 1800 rpm polyphase motors, as well as single-phase, ratings from 1- to 5-hp. This extra-value feature—now specified as optional equipment—responds to both current and temperature to help protect the motor from damage due to excessive overload currents, stalls or high ambient temperatures.

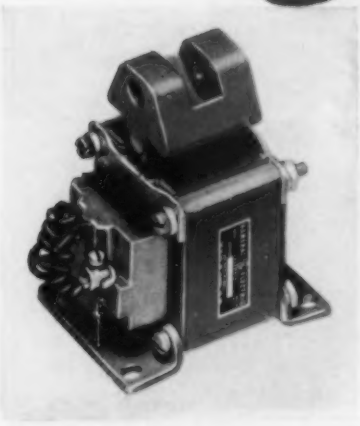
Add this to many other quality features built into the line, for example: improved operating characteristics, with full-load speed averaging 25 rpm higher than an old-design motor of same rating; better use of space for smaller, lighter design without sacrificing full-power performance; easy-access conduit box that rotates for connection from top, bottom or sides. See Bulletin GEA-5980.

*Registered trade-mark of General Electric Co.

GENERAL ELECTRIC

Digest

PRODUCT HIGHLIGHTS



Strongbox solenoids cover all ratings, mount 5 ways, require 22% less space

You can build straight-line mechanical force into your machine designs easier than ever with General Electric's line of industrial strongbox solenoids.

Complete rating coverage is supplied by nine basic frame sizes. These sizes provide more accurate selection in push or pull forms, 24 to 600 volts, 60 cycles, a-c and d-c. Nominal ratings at maximum stroke are: ½" pull—3.8 to 40 pounds; 1" pull—1.4 to 36 pounds; ½" push—2.5 to 33 pounds; 1" push—4.3 to 28 pounds.

Greater flexibility is provided because these versatile solenoids can be mounted in five different ways. Brackets can be moved to any of four sides, or thru-bolts can be used. Wiring is easier because both leads and built-in terminal boards (which may be connected if desired) are furnished on strong-box coils.

Longer life—proved by many customer applications—results from features such as laminated steel plunger and frame that are designed to distribute stress, glass fabric plunger guide that resists wear, and strongbox construction that resists entrance of oil, dust or moisture.

Smaller size—Up to 22% smaller for the same power ratings as previous models—permits a saving of space on your machines and smaller enclosure. This size reduction is made possible by more efficient utilization of steel, copper and insulation. For full details, see Bulletin GEA-6215.

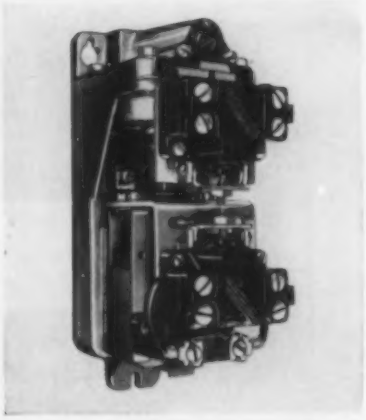
Pneumatic time-delay relays offer repetitive accuracy

Where high repetitive accuracy of a time-delay relay is needed—for example in machine-tool sequencing operations—make the General Electric pneumatic time-delay relay your choice. It provides repetitive accuracy of ±10 per cent of average time setting, including effects of variations in humidity and atmospheric pressure.

Relay affords stepless adjustment for a time delay ranging ⅕ to 180 seconds by turning a single screw, easily accessible from front of relay.

With snap-action silver contacts and strongbox coil, relay is designed to last for millions of operations, even on rapid-duty cycles. Greater dependability is provided by its rigid, die-cast aluminum construction, and a filtered air intake that keeps out dirt and dust.

Time delay can be arranged to time out after energizing or de-energizing.



Unit, rated at 25 amperes "make and carry", is available in open form or NEMA enclosures and with or without instantaneous closing contacts. See Bulletin GEC-1425 for details.

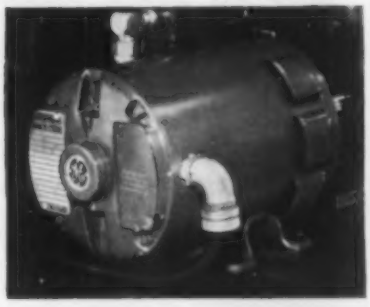
FHP machine-tool motor gets 10-year lubrication

Designed specifically for machine-tool use, these General Electric totally enclosed, fan-cooled fhp motors have ball-bearing construction with long-life grease to meet the heavy thrust conditions of many machine-tool applications.

Under normal operating conditions, factory lubrication with improved-type grease should last 10 years and reduce routine maintenance time and cost.

Welded-on steel base gives strong, solid mounting that withstands shock and vibration, maintains accurate motor alignment. Compact, yet sturdy construction can simplify your design and assembly problems.

Years-ahead motor design enables these motors to meet the tough requirements of frequent start-stop service and plugging. Ratings are ¼, ⅓, ½, ¾ hp in 60/50 cycles, at voltages of 208–220/440, 220/380, 500. For additional details, send for Bulletin GEC-1306.



General Electric Co., Apparatus Sales Division, Section A668-134, Schenectady 5, N. Y.

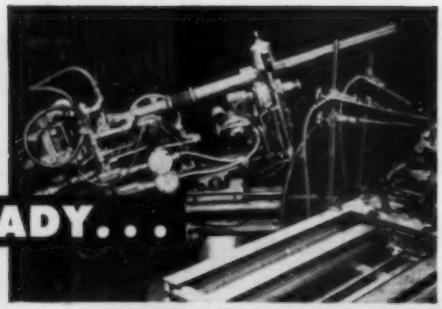
Please send me the following bulletins:

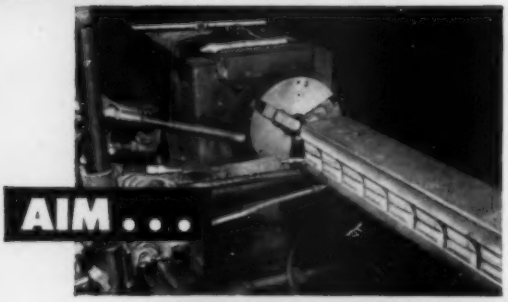
√ for reference purposes		× for immediate project	
☐ GEA-5980	Tri-Clad '55' motors (1-5 hp)	☐ GEC-1306	Fhp machine-tool motors
☐ GEA-6122	Tracer Control systems	☐ GEC-1425	Pneumatic time-delay relay
☐ GEA-6215	Strongbox solenoids		

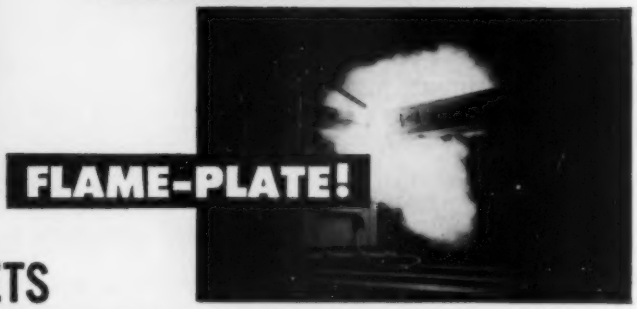
Name ..... Company .....

City ..... State .....

LINDE's Flame-Plating gun is operated entirely by remote control. At control panel (below) is operator, who observes process through safety-glass window. At right, Flame-Plating gun is seen as workpiece is secured in fixture (top), as gun is brought into range (center), and at the instant of a blast in the plating action (bottom).







Not all guns shoot BULLETS ...this one gives metal parts EXTRA WEAR RESISTANCE

A dramatic and useful coating process for metal parts has been developed by LINDE engineers to provide extra resistance to wear and abrasion. This method, called Flame-Plating, utilizes a special, rapid-fire gun to apply an extremely hard coating of tungsten carbide or aluminum oxide on precision parts subject to unusual wear or fretting corrosion.

The Flame-Plating gun consists of a barrel and a mechanism for loading precise amounts of powdered coating material and explosive gases into a firing chamber. The powder—tungsten carbide or aluminum oxide—remains suspended in the gases until a controlled spark ignites the mixture.

The resulting detonation creates heat and pressure waves of tremendous force. These waves rip through the gas-and-powder mixture at supersonic velocity. The particles are hurled against the work with terrific impact. They fuse together and build up until the desired thickness is obtained.

The temperature of the workpiece seldom exceeds 400 degrees F. Thus precision parts can be Flame-Plated without risk of changes in physical dimensions or metallurgical properties. Coatings can be Flame-Plated in thicknesses from .002 to .010 inch, and finished to 0.5 microinches rms. Practically all metals can be Flame-Plated.

The extra resistance of Flame-Plated parts to wear, abrasion, and fretting corrosion has been proved in actual service. Vital parts in aircraft and automotive power plants, hydraulic systems, and heating units, as well as textile and canning machinery, plug and ring gages, bearings, and seals have all had their useful life greatly extended—and economically, too—with Flame-Plating by LINDE. Find out how Flame-Plating can help you improve your own design. Write for a free copy of the booklet, "Flame-Plating," F8065. Address "Flame-Plating, Department P-3."

LINDE AIR PRODUCTS COMPANY

A Division of Union Carbide and Carbon Corporation

30 East 42nd Street UCC New York 17, New York

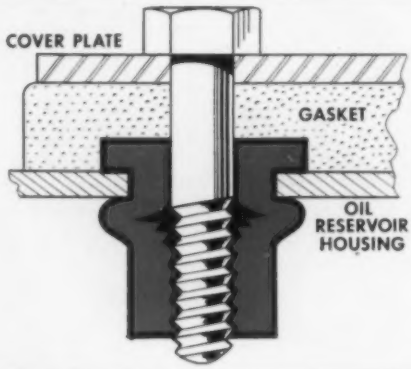
In Canada: Linde Air Products Company, Division of Union Carbide Canada Limited, Toronto

The term "Linde" is a trade-mark and FPL is a service-mark of Union Carbide and Carbon Corporation.

Flame-Plating by Linde

B.F.Goodrich Rivnuts

cut assembly time and costs by 50%



ELIMINATE WELDING, TAPPING AND CLEANING

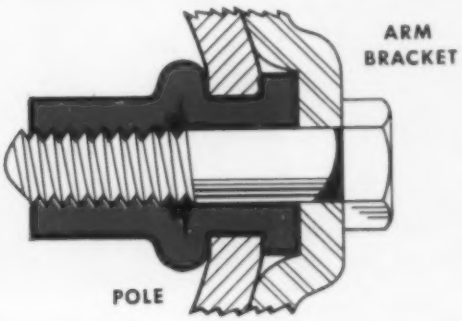
A fastening job on oil reservoir housings formerly took 5 operations. First the housings had to be detoured from the assembly line. Then nutplates were welded on the inside, drilled, tapped and cleaned before the covers could be attached.

By switching to B. F. Goodrich Rivnuts, this whole job is now done in half the time. Rivnuts are installed by one man from one side, in seconds. They provide firm, accurate nutplates with six clean threads for fastening. Flow of assembly is uninterrupted.

ONE MAN NOW DOES THE WORK OF TWO

Using conventional nuts and bolts, it took two men to fasten the arm bracket on street light poles. Now, with B. F. Goodrich Rivnuts, one man does this work in the same amount of time.

In the factory, one worker installs Rivnuts in the aluminum poles simply, quickly. The assembler in the field merely lines up the brackets, slips the attachment bolts into position and tightens them. As for strength, tests show that the pole or arm bracket will fail before the Rivnuts.



Rivnuts provide at least 6 clean threads in one simple operation!

1 Rivnut is threaded onto pull-up stud of a manual or pneumatic heading tool.

2 Rivnut is inserted—head firmly against work — tool at right angles to work.

3 Tool lever operates pull-up stud, forming a bulge in the Rivnut shank.

4 After upset, Rivnut threads are still clean and intact ready for screw attachment.

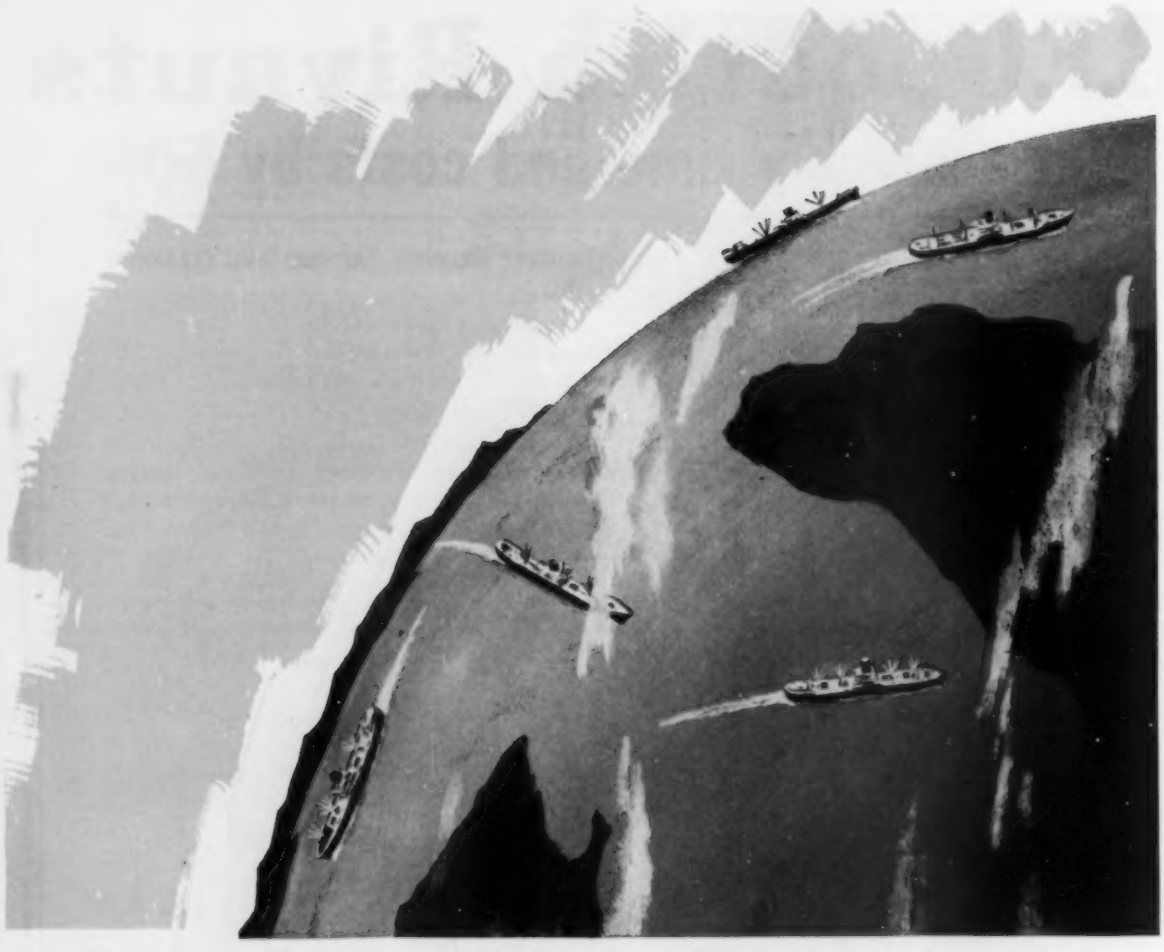
SEND NOW FOR FREE RIVNUT DEMONSTRATOR

Demonstrates with motion how Rivnuts fasten *to* and *with*. Explains construction, gives proved applications. Write to *B. F. Goodrich Rivnuts, Department PE-37, Akron, Ohio.*

B.F.Goodrich

AVIATION PRODUCTS

a division of The B. F. Goodrich Company, Akron, Ohio



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the performance and the name are the same around the world!

FOR YEARS SHELL TELLUS OIL has been top-rated as both a lubricant and a control fluid for complex hydraulic systems. Its ability to combat foaming, oxidation, rust, sludge-formation and wear has earned it nation-wide popularity.

You may be glad to know that the equipment you manufacture can get the same efficient protection in foreign countries. Tellus* Oil is available to your foreign customers from near-by points. It will be the same Tellus Oil that your domestic customers rely upon. Write Shell Oil Company, 50 West 50th St., New York 20, New York, or 100 Bush Street, San Francisco 6, California.

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Machinery manufacturers:
Your customers abroad will receive the same Shell Tellus Oil that your domestic customers enjoy. And this same uniformity applies to

SHELL TURBO OIL—gives anti-wear lubrication for utility, industrial and marine turbines

SHELL ALVANIA GREASE—multi-purpose industrial grease, and a complete line of other

SHELL INDUSTRIAL LUBRICANTS

SHELL TELLUS OIL

SHELL

DESIGNING WITH ALUMINUM

NO. 6

This is one of a series of information sheets which discuss the properties of aluminum and its alloys with relation to design. Extra or missing copies of the series will be supplied on request. Address: Advertising Department, Kaiser Aluminum & Chemical Sales, Inc., 1924 Broadway, Oakland 12, California.

THERMAL TREATMENTS

PROPER USE OF ANNEALING AND HEAT TREATMENT WIDENS SCOPE OF APPLICATION, DESIGN AND FABRICATION WITH ALUMINUM ALLOYS

(THIS ADVERTISEMENT REPEATED IN RESPONSE TO THE HIGH INTEREST EXPRESSED BY ENGINEERS AND DESIGNERS.)

FAMILIARITY with the thermal treatments which apply to aluminum and with their influence on metal behavior is frequently as important in design and alloy selection as in fabrication. This is especially the case in dealing with the wrought alloys, where forming of some sort is a regular concern; with the cast alloys the problems customarily revolve around such requirements as castability, machinability and strength, but not forming.

The major thermal treatments are annealing, and the solution and precipitation heat treatments which are often referred to singly or together under the general, but loose term "heat treatment." Their intelligent consideration in design and manufacture makes it possible in many cases to derive maximum advantage of aluminum's combination of desirable properties such as light weight with strength, corrosion resistance, conductivity, reflectivity and appearance.

The metallurgical aspects of the thermal treatments are quite complex, but it is possible to discuss their processes and effects satisfactorily in a general way insofar as they affect design problems.

Annealing Only Way To Remove Hardening

Annealing is a treatment to soften the metal and render it more ductile and susceptible to forming operations. It applies to both the non-heat-treatable and heat-treatable alloys although there is some difference in how the annealing treatment accomplishes its purpose.

Because cold working produces progressive hardening, it is frequently necessary in fabrication to anneal non-heat-treatable material after one or more sets of fabricating operations in order to proceed with further forming. With most of the group of alloys, annealing is carried out by raising the metal to a temperature of about 650°F although a higher temperature, 760°F, is required for the manganese-type alloy 3S that is so generally used for many formed articles. Normal air cooling to room temperature follows.

During the annealing process the grains which have been deformed by

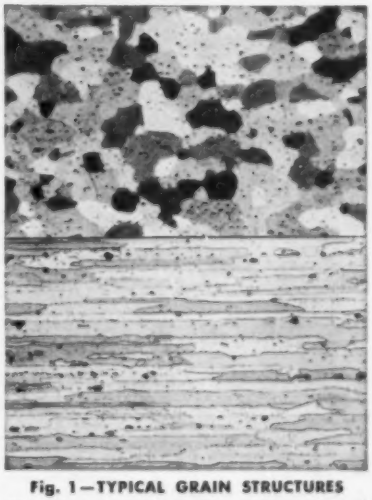


Fig. 1—TYPICAL GRAIN STRUCTURES
Photomicrographs show grain structures typical of non-heat and heat-treatable wrought alloys. Top: 50S-0 (anodic etch); bottom: 75S-T6 (phosphoric-Keller's etch).

cold working are recrystallized into new ones that are equiaxed, and the metal reaches a stable condition in which there is no strain. It is important that the material be brought to temperature as rapidly as possible and that it be exposed to heat only long enough to bring the entire part to temperature. Slow heating rates and overlong heating tend to create larger grains in the annealed metal, a structure that is usually undesirable.

When annealed, metal which has had only a small degree of cold work also tends to form larger grains than that which has been work-hardened considerably. With the non-heat-treatable alloys, of course, strength and hardness can be increased again, after annealing, only by further cold working. Therefore, where annealing is required at some intermediate stage in fabrication, careful consideration should be given to its exact location.

Cooling Rate Critical For Heat-Treatable Alloys

Annealing of the heat-treatable alloys removes the effects not only of any cold working the material has undergone but also of previous heat treatment, so that practice differs from that followed with the non-heat-treatable alloys. Precipitated particles of alloying elements must be coalesced, which reduces them in number and enlarges them in size, thus nullifying their hardening effect.

Higher temperatures, ranging between 750°F and 800°F, are therefore required, and the rate of cooling becomes of critical importance. It must be slow, no more than 50° per hour down to temperatures of at least 500°F, so that constituents taken into solid solution are precipitated as relatively large particles and heat treating effects are avoided. As with the non-heat-treatable alloys, excessive temperature and time may cause undesirable grain growth.

The annealed tempers of the heat-treatable alloys are used for forming purposes. Aside from the fact that there would be no reason for using them in a finished item, several of this group of alloys have lower resistance to corrosion resistance in the annealed temper as compared with heat-treated material.

The fact that a large class of alloys acquires optimum properties through heat treatment is a strong factor in extending the versatility and applications of aluminum. These alloys are heat-treatable because some of the elements and compounds go into solution with aluminum at elevated temperatures, and then after appropriate treatment are precipitated out at lower temperatures. This action promotes a structure that resists internal crystal slip and so increases the strength and reduces the ductility of the material.

Heat-treatable alloys include those of the highest strength, ranging up to 83,000 psi tensile strength for 75S. In general, they fall into three types, depending upon the chief alloying elements: the magnesium-silicide, copper (including copper-magnesium) and zinc-magnesium groups.

PLEASE TURN TO NEXT PAGE ➡

TABLE 1 • TYPICAL HEAT TREATMENTS (1)

Alloy	Solution HeatTreatment (2)		Precipitation Heat Treatment		
	Metal Temp. °F	Resulting Temper (3)	Metal Temp. °F	Time, Hours	Resulting Temper (3)
11S	935-970	11S-T4	325	12-16	11S-T6
14S	930-950	14S-T4 (4)	335-345	8-12	14S-T6
17S	935-950	17S-T4 (4)			
18S	950-970	18S-T4	340	8-12	18S-T61
24S	910-930	24S-T4 (4)			
25S	955-970	25S-T4	340	8-12	25S-T6
32S	945-960	32S-T4	340	8-12	32S-T6
A51S	960-980	A51S-T4	340	8-12	A51S-T6
53S	960-980	53S-T4	340	8-12	53S-T6
61S	960-1000	61S-T4 (4)	325-340	10-16	61S-T6
75S	860-925	75S-W	245-255	22-26	75S-T6
			or 210 followed by	4	
			310	4	
195 (5)	960	195-T4	310	3-6	195-T6
356 (5)	1000	356-T4	310	3-5	356-T6

(1) Figures are given as a guide only; more details may be obtained for specific applications.

(2) Solution heat treatment times depend on the section thickness, varying from 10 minutes for thin sections up to several hours for thicker sections. Soaking should be followed by immediate quench; in cold water for light sections, in boiling water for heavier, thicker sections.

(3) Addition of cold work would change tempers —i.e., 11S-T3, 11S-T8, etc.

(4) After aging at room temperature for approximately four days.

(5) Casting alloys. Soaking time at solution temperature for average casting is 12 hours—hot water quench.

Heat Treatment Consists of Two Phases

Heat treatment to attain maximum strength consists of two phases: solution heat treatment and precipitation or aging, which may be natural or artificial (the latter being termed precipitation heat treatment).

In solution heat treatment, the metal is heated to temperatures ranging approximately from 900°F to 975°F (see Table 1). At that point certain of the alloying elements go into solution, or dissolve, in the solid metal. When the temperature is quickly lowered by quenching, the alloying elements remain in solid solution.

Immediately after quenching, the metal is quite soft. But it is not in a state of equilibrium because the material is in a supersaturated solution—the solid solubilities of these alloying elements in aluminum being less at room temperature than they are at solution heat treating temperatures.

Within a few minutes, however, the alloying constituents begin to precipitate as extremely fine particles in the solid metal and the strength begins to increase. There is considerable difference between alloys in the rate of this precipitation, or natural aging, as shown by Figures 2a and 2b. In 24S it progresses rapidly and uniformly at room temperature and is virtually completed at the end of four days, with maximum strength and hardness then obtained.

In 75S, natural aging proceeds at a much slower rate: there is practically no increase in strength during the first hour and it is actually many months before 75S will attain maximum strength. Therefore, in practice this alloy requires a low-temperature thermal treatment after solution heat treatment to have adequate precipitation for desirable strength. This is the artificial aging process called precipitation heat treatment.

FIG. 2a • RATES OF NATURAL AGING OF SOME HEAT-TREATABLE ALLOYS

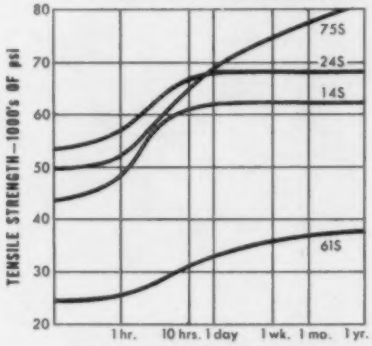
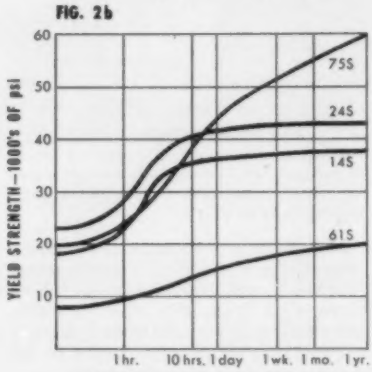


FIG. 2b



Another type of behavior is exhibited by 61S. It ages naturally at room temperature to one level of strength in four days, but can be given precipitation heat treatment (before or after natural aging) to T6 temper for maximum strength. It is quite common for a fabricator to obtain 61S material in the first condition (T4 temper) from the mill, do necessary forming and then achieve the full T6 properties by the relatively simple precipitation heat treatment.

Possibilities for Forming In Interim Condition

The behavior of the heat-treatable alloys as outlined above—especially the "delayed action" of varying duration between quenching and full precipitation—offers considerable opportunity in design and planning for forming operations.

For example, it is possible to solution heat treat and quench, do considerable forming while the metal is still relatively soft and then age the formed part either naturally or by precipitation heat treatment to maximum strength. This procedure can help avoid distortion problems likely to occur when forming the part entirely in the annealed temper and then heat treating, especially where light gauge material is being used.

Refrigerating material after quenching also slows down the rate of precipitation to such an extent that there is no increase in strength or hardness for an extended period of time. It is common practice to handle rivets made of heat-treatable metal in this manner, and the air-frame manufacturers have further developed the technique to a high degree for use in forming large parts and in bending large extrusions.

Other Thermal Treatments

Although they are of only minor interest to the designer, there are several other thermal treatments used with aluminum, such as stabilization and homogenization which are used in aluminum rolling mills and the treatment of some castings for stress relief and growth removal. Stabilization is a low-temperature treatment to establish the harder tempers of some of the magnesium-type non-heat-treatable alloys in a stable condition. Homogenizing consists of soaking the ingots of heat-treatable wrought alloys at elevated temperatures to distribute the alloying constituents uniformly before rolling.

More detailed assistance with design, alloy selection and fabrication and heat treatment procedure is obtainable through any of the Kaiser Aluminum sales offices located in principal cities. Or write to Kaiser Aluminum & Chemical Sales, Inc., 1924 Broadway, Oakland 12, California.

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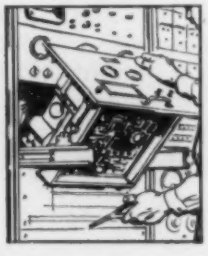

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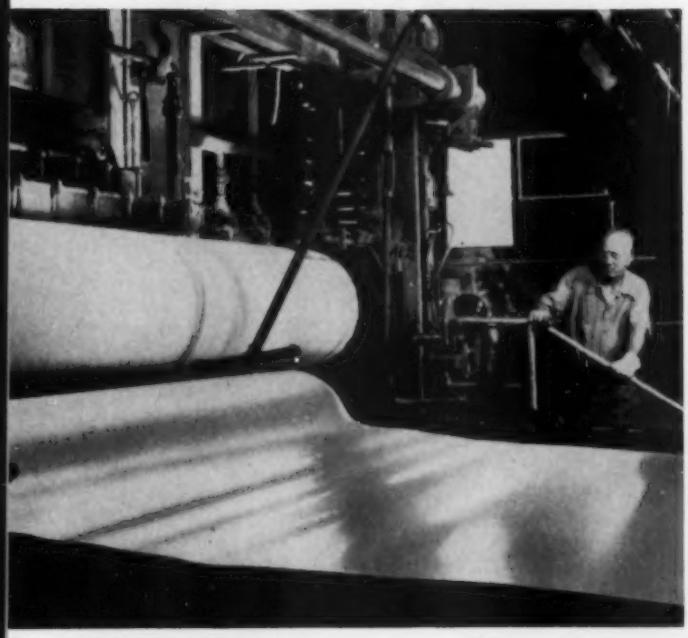

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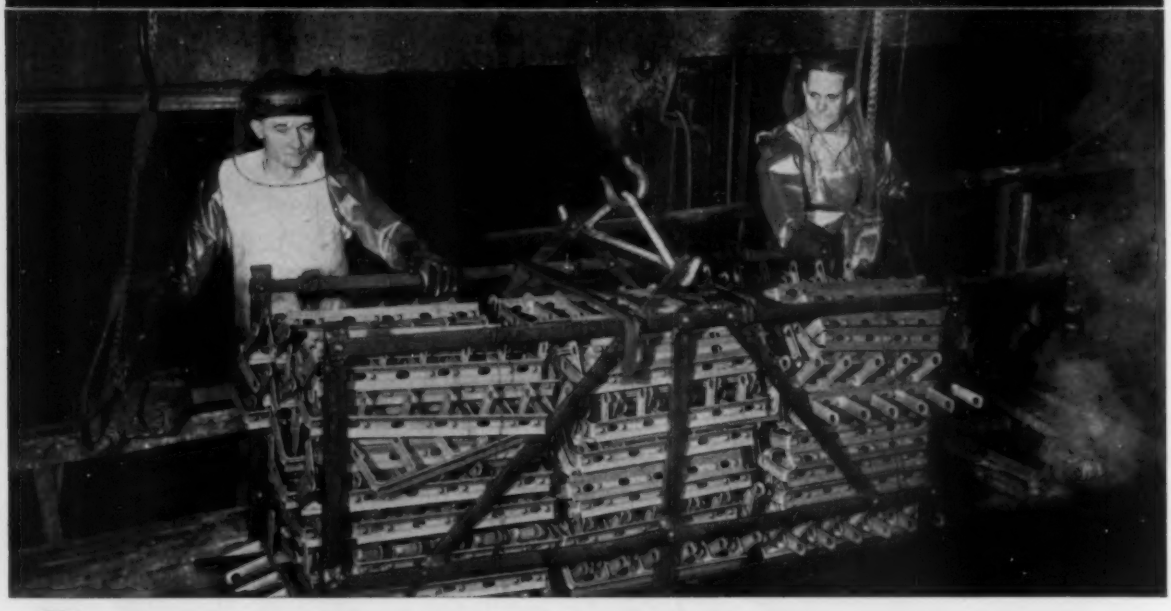

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- Pump parts
- Screws
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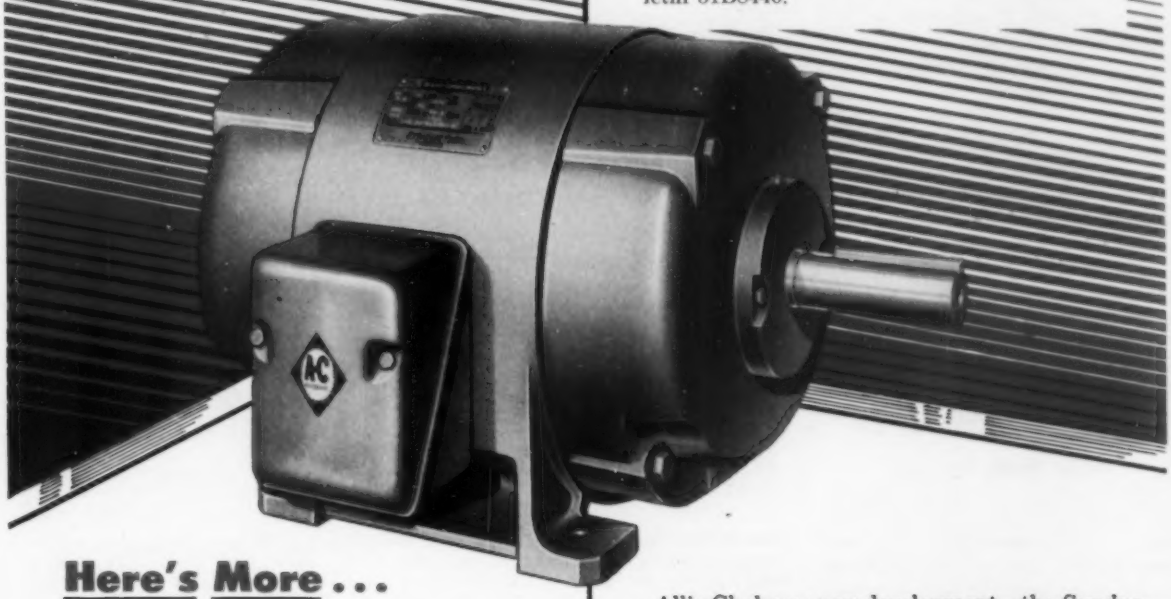

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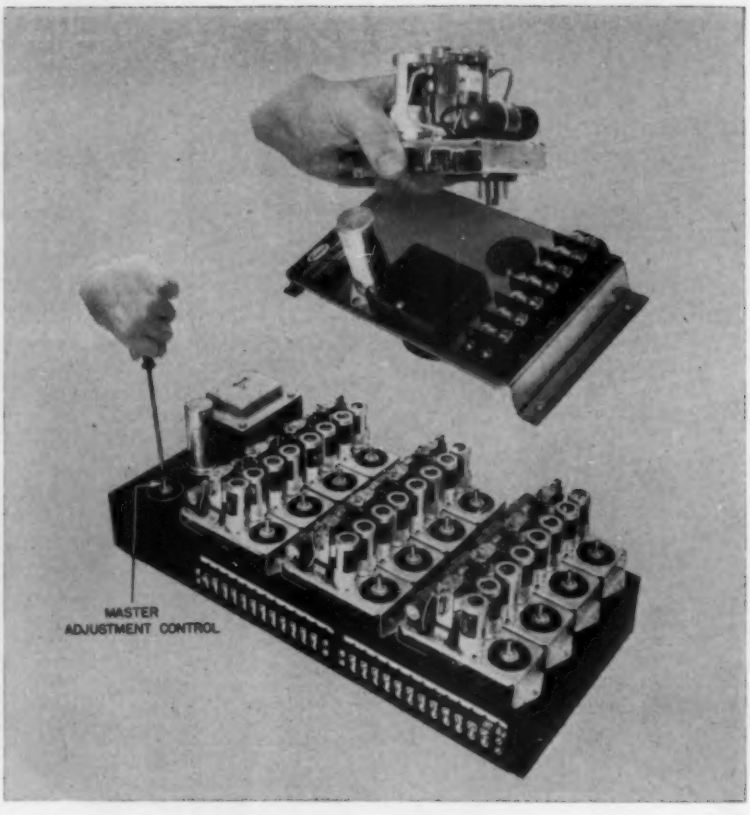

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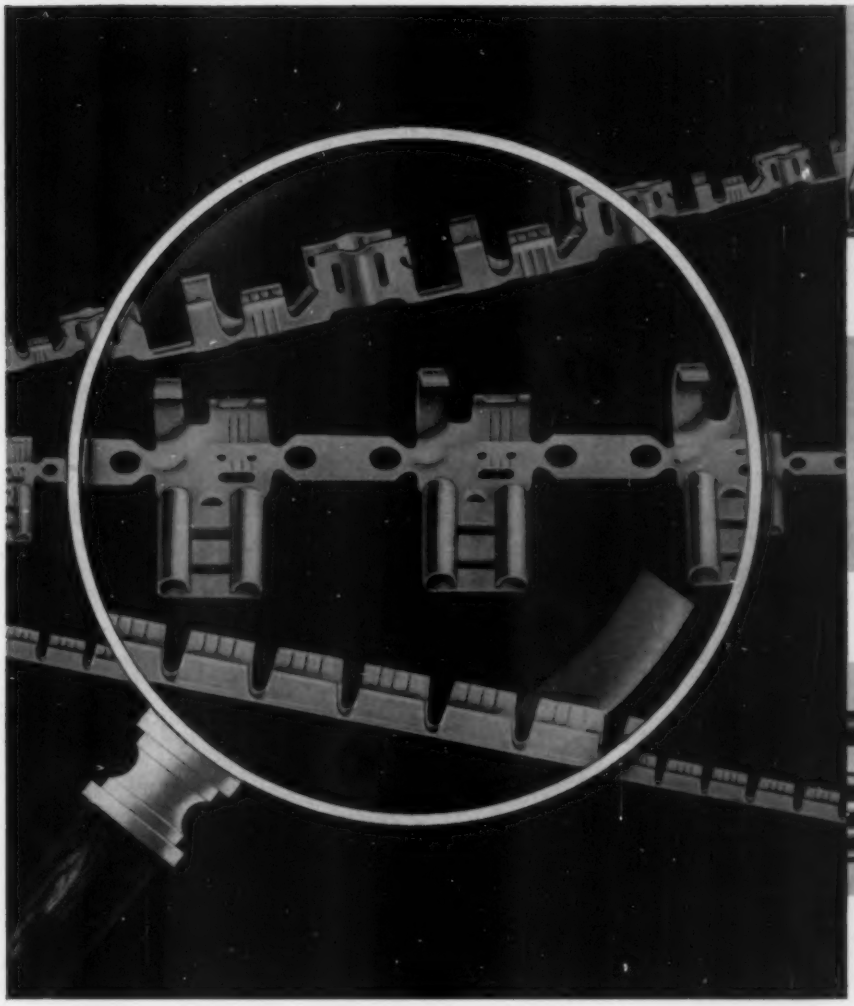
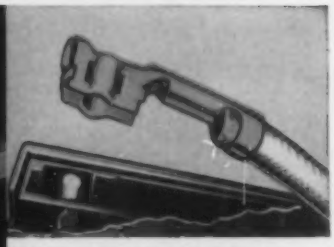
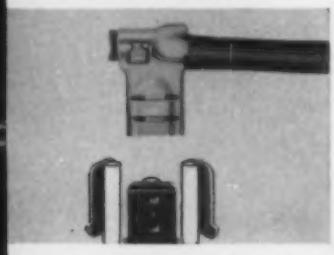
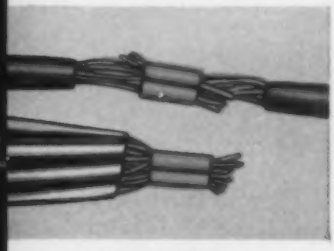




Pin receptacle made of Duraflex—hard temper, in strip form, at left, as fed into the automatic wire terminator. Finished form above.



Flag "Fastan," a receptacle for .250" x .032" flat tabs, made of Duraflex—hard temper.



Connector for splicing coil windings to stranded lead wires in hermetically sealed refrigeration motors, made of Duraflex.

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AMP Inc., Harrisburg, Penna., is one of the leaders in the development and manufacture of solderless wiring devices. For their connectors to be used in refrigeration service they turned to Duraflex, Anaconda's superfine-grain Phosphor Bronze with superior endurance limit.

The superfine-grain structure of Duraflex offers greatly improved fatigue resistance and formability . . . and a finer, harder, smoother surface. It provides the extra resilience and strength for constant and enduring contact pressure essential in this type of connection. It also offers high resistance to corrosion by the moisture-absorbing additive in refrigerant, plus, of course, good electrical conductivity.

Duraflex is a premium product—yet it costs no more than ordinary phosphor bronze. Find out for yourself how Duraflex can help you cut costs, make a superior product. It is produced in sheet metal up to .062" thick and in wire up to 3/16" diameter. Write today for free samples you can test—specifying gage and temper. Address: The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Limited, New Toronto, Ontario.

5674

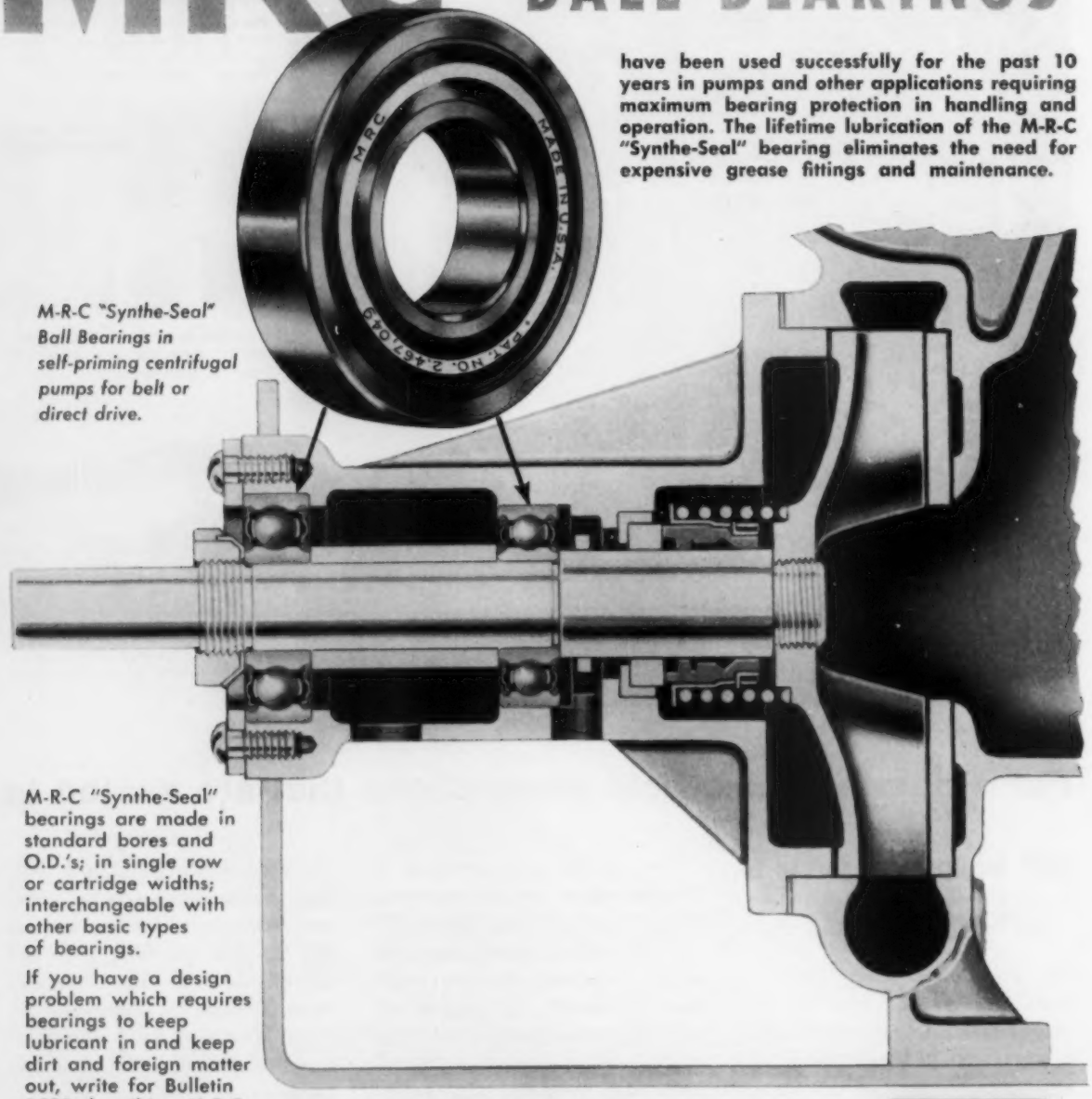
DURAFLEX

The New Superfine-Grain Phosphor Bronze with Greater Endurance Limit

An ANACONDA® Product

MRC "Synthe-Seal" BALL BEARINGS

have been used successfully for the past 10 years in pumps and other applications requiring maximum bearing protection in handling and operation. The lifetime lubrication of the M-R-C "Synthe-Seal" bearing eliminates the need for expensive grease fittings and maintenance.



M-R-C "Synthe-Seal" Ball Bearings in self-priming centrifugal pumps for belt or direct drive.

M-R-C "Synthe-Seal" bearings are made in standard bores and O.D.'s; in single row or cartridge widths; interchangeable with other basic types of bearings.

If you have a design problem which requires bearings to keep lubricant in and keep dirt and foreign matter out, write for Bulletin 1528 describing M-R-C "Synthe-Seal" Ball Bearings.

Consult OUR Engineering Department on YOUR bearing problems

MRC BALL AND ROLLER *bearings*

MARLIN-ROCKWELL CORPORATION

Executive Offices: **Jamestown, N.Y.**

over 8,000 Different Cylinder SELECTIONS—

Miller AIR AND HYDRAULIC CYLINDERS AND BOOSTERS "IN STOCK" for immediate delivery...

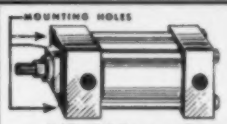
See Miller Bulletins A-105K (Air) and H-104K (Hydraulic) for Complete Dimensions and Engineering Data on these "in-stock" sizes and other Custom Miller Cylinders in bores up to 20" and strokes up to 22 feet.

"IN-STOCK" MODELS

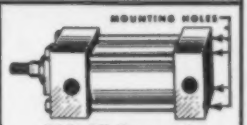
"A" Signifies Miller 200 psi Air Cylinders; "H", 2000 psi Hydraulic Cylinders. Interchangeable Mountings Are Shown In Red On Drawings.

A61 and H61
Flange Mounting on Rod End
(A61 not available in 8" bore)

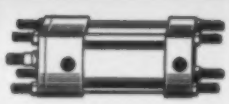
A62 and H62
Flange Mounting on Cap End
(A62 not available in 8" bore)



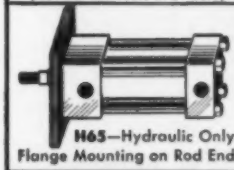
A63—8" Bore only
Flange Mounting on Rod End



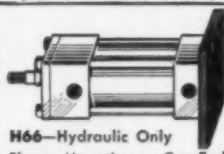
A64—8" Bore only
Flange Mounting on Cap End



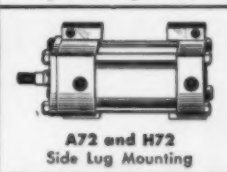
A50 & H50—Tie Rods not extended beyond nuts.
A51 & H51—Tie Rods extended both ends (shown).
A52 & H52—Tie Rods extended. Cap End only.
A53 & H53—Tie Rods Extended. Rod End only.
A54 & H54—Two Tie Rods extended at both ends.



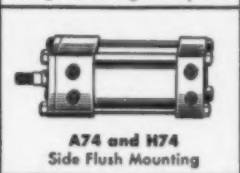
H65—Hydraulic Only
Flange Mounting on Rod End



H66—Hydraulic Only
Flange Mounting on Cap End

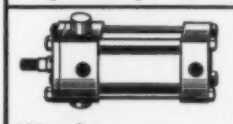


A72 and H72
Side Lug Mounting

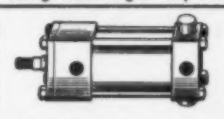


A74 and H74
Side Flush Mounting

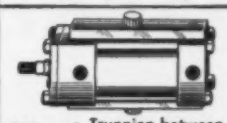
A77 and H77
Side or Foot Mounting



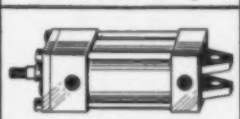
A81 and H81 Trunnion Mounting on Rod End



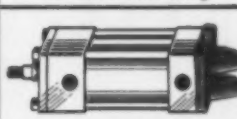
A82 and H82 Trunnion Mounting on Cap End



A83 and H83 Trunnion between Head and Cap (one week delivery)



A84 and H84
Pivot Mounting



A86 and H86
Pivot Mounting

IN STOCK BORES

	BORES	ROD DIA.	ROD TURN DOWN & THREADS	"IN-STOCK" STROKES (in inches)																					
AIR	1½	⅝"	7/16-20	Cushioned			3	4	5	6	7	8	9	10	11	12									
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12									
	2	⅝"	7/16-20	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	2½	⅝"	7/16-20	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	3¼	1"	¾-16	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	4	1"	¾-16	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	5	1"	¾-16	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	6	1⅜"	1-14	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	8	1⅜"	1-14	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
HYDRAULIC	1½	⅝"	7/16-20	Cushioned			3	4	5	6	7	8	9	10	11	12									
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12									
	2	1"	¾-16	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	2½	1"	¾-16	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	3¼	1⅜"	1-14	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	4	1¾"	1¼-12	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	5	2"	1½-12	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36

(4) (3)

(1) "A" and "H" Models 82, 84 and 86 with strokes over 18" require stop tubes.

Column strength requires larger diameter piston rods for the following:

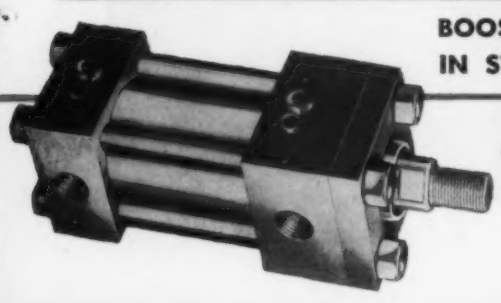
Air Cylinder Models A82, 84, and 86 with strokes inside area (1), when operated at 100 psi and over;

All hydraulic models with strokes inside area (2) and Models H82, 84, and 86 with strokes in area (4), when operated at 2000 psi and over;

Models H82, 84 and 86 with strokes inside area (3), when operated at 1000 psi and over.

Depending upon Trunnion Pin location, "A" and "H" Models 83 with standard diameter piston rods can have longer strokes than Models 82, 84 and 86.

See Miller File #251 for oversize piston rod and stop tube requirements.



BOOSTERS IN STOCK

Immediate Delivery on the following Miller 25 to 1 Ratio Boosters (80 psi air input produces 2000 psi hydraulic oil output): Model B4, 5" bore, 1" dia. ram, 6" and 12" strokes; Reciprocating Booster Model DA77-RBAB, 5" bore, 1" dia. ram, 6" stroke. Also Booster Tanks, 5" dia., 6" and 10" heights.

Write For Catalog and Stock Price List

Miller

MILLER FLUID POWER DIVISION
FLICK-REEDY CORP.

2002-04 N. Hawthorne Ave., Melrose Park, Ill.

AIR & HYDRAULIC CYLINDERS • BOOSTERS • ACCUMULATORS
COUNTERBALANCE CYLINDERS

How SKF Saved in 7 Ways

and at the same time improved its roller bearing cages by using the right

Revere Brass Strip

SKF Industries, Inc., Philadelphia, Pa., like other progressive organizations, is constantly seeking new ways to improve its products and at the same time cut production costs.

With this in mind they recently reviewed the kind of brass which was being used in their spherical roller bearing cages from the standpoints of quality and fabrication. It was then that Revere's Technical Advisory Service studied the problem first-hand and made recommendations to the **SKF** production and engineering departments.

SKF IMPROVED TYPE "C" Spherical Roller Bearing cut away to show how the cage, made of Revere Brass Strip, fits into the bearing. Due to its advanced internal design, this bearing provides greatly increased capacity and service life.

HERE IS "window-type" cage of SKF Spherical Roller Bearing, made in two pieces, one for each row of rollers. Cage is made from rugged Revere Brass Strip at the Shippensburg, Pa., plant of SKF Industries, Inc.

The result was the adoption of specification changes in brass strip as recommended by Revere which gave SKF these 7 money, time and tool-saving advantages:

1. One bore pressing operation has been eliminated. Machining is more easily accomplished. Less machining is required.
2. Tool life has been increased with some speeds increased up to 100% and feeds up to 30%.
3. Rework due to burrs has been greatly reduced. One step less is required in the deburring operation while savings through reduced cycle time for remaining deburring operations are up to 40%.
4. Chips are small now . . . there is no "angel hair" to clutter work area.
5. Life of punch used in notching roller bearing cage has been doubled. Now a run may be completed without making tool adjustments due to sharpening tools.
6. Machining speeds and feeds have been substantially increased over those in machining the former alloy.
7. Die setters report that considerable work has been eliminated in setting up the tools used.

And, all of these money-saving things were accomplished without sacrificing quality—in fact the quality of these roller bearing cages was *improved!*

This is still another eye-opening example of Revere supplying the metal that will do the best job and with the greatest economy . . . be it brass, copper or aluminum or any one of their alloys.

Why not call in Revere's Technical Advisory Service to review your operation? It may mean money saved with an improved product to boot.

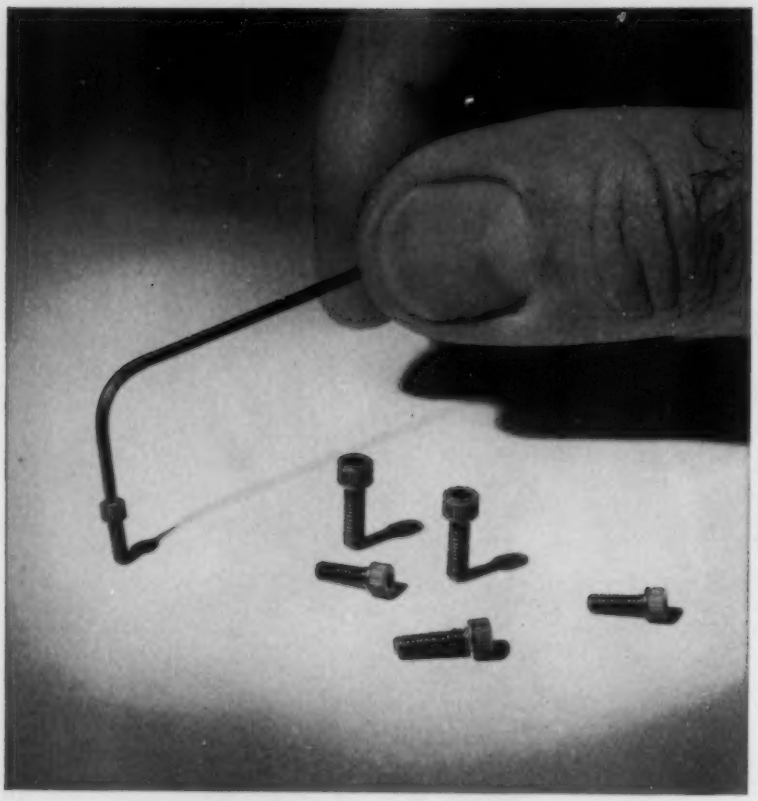
REVERE COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801
230 Park Avenue, New York 17, N.Y.

Mills: Baltimore, Md.; Brooklyn, N.Y.; Chicago, Clinton and Joliet, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Newport, Ark.; Rome, N. Y. Sales Offices in Principal Cities, Distributors Everywhere.

COPPER • BRASS • REVERE • ALUMINUM • 1801

Miniature screws aid standardization of small devices



Standard UNBRAKO miniature socket head cap screws are available in sizes # 0, # 1, # 2 and # 3, in heat treated alloy steel or stainless steel, at your authorized industrial distributor's. Standard lengths range from 1/8 to 1/2 in.

Tiny close-tolerance Unbrako screws available in standard sizes

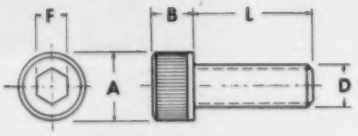
New economies in the design of space-saving miniature equipment are possible with these UNBRAKO miniature socket head cap screws. Manufactured to timepiece precision, available locally, they save the costly necessity of designing special screws to fasten tiny parts in compact units. They're ideal for use in typewriters, calculators and computers, servomechanisms, electric and electronic equipment—and in countless other small, intricate devices where maximum reduction in bulk and weight is required with no sacrifice in strength of individual components or assemblies.

Fingers grip the knurled heads on these tiny screws positively for easy handling and fast assembly. Uniform hex sockets assure maximum wrenching torque. Controlled fillets under the heads prevent shearing of the heads. Threads are fully formed for maximum strength and exact fit. Extremely accurate head diameters permit their use in countersunk holes, saving weight by reducing the length of the screw required and making flush designs possible.

These standard UNBRAKO miniature screws are available at your authorized industrial distributor's. See him today. Or write us for Bulletin 2055 and samples. Unbrako Socket Screw Division, STANDARD PRESSED STEEL Co., Jenkintown 28, Pa.

HEAT-TREATED ALLOY STEEL

Class 3 Fit Standard



	Diameter	Threads per Inch NC	Threads per Inch NF	Length	Recommended Installation Torque in Inch-Pounds NC	Recommended Installation Torque in Inch-Pounds NF	Weight per 1000 in Pounds
#0	A .104		80	1/8		2.0	.152
	B .060		80	3/16		2.0	.182
	D .060		80	1/4		2.0	.210
	F .050		80	3/8		2.0	.265
#1	A .118		72	1/8		3.5	.27
	B .073		72	3/16		3.5	.32
	D .073		72	1/4		3.5	.37
	F .050		72	3/8		3.5	.47
#2	A .140	56		3/16	6.0		.42
	B .086	56		1/4	6.0		.50
	D .086	56		3/8	6.0		.58
	F 1/16	56		1/2	6.0		.70
#3	A .161	48		3/16	8.5		.59
	B .099	48		1/4	8.5		.70
	D .099	48		3/8	8.5		.81
	F 5/64	48		1/2	8.5		1.03

Standard Screws are threaded to the head. Special materials, lengths, and threaded lengths are available. One "High-Titan" UNBRAKO hex key is included with each package of 100 screws.

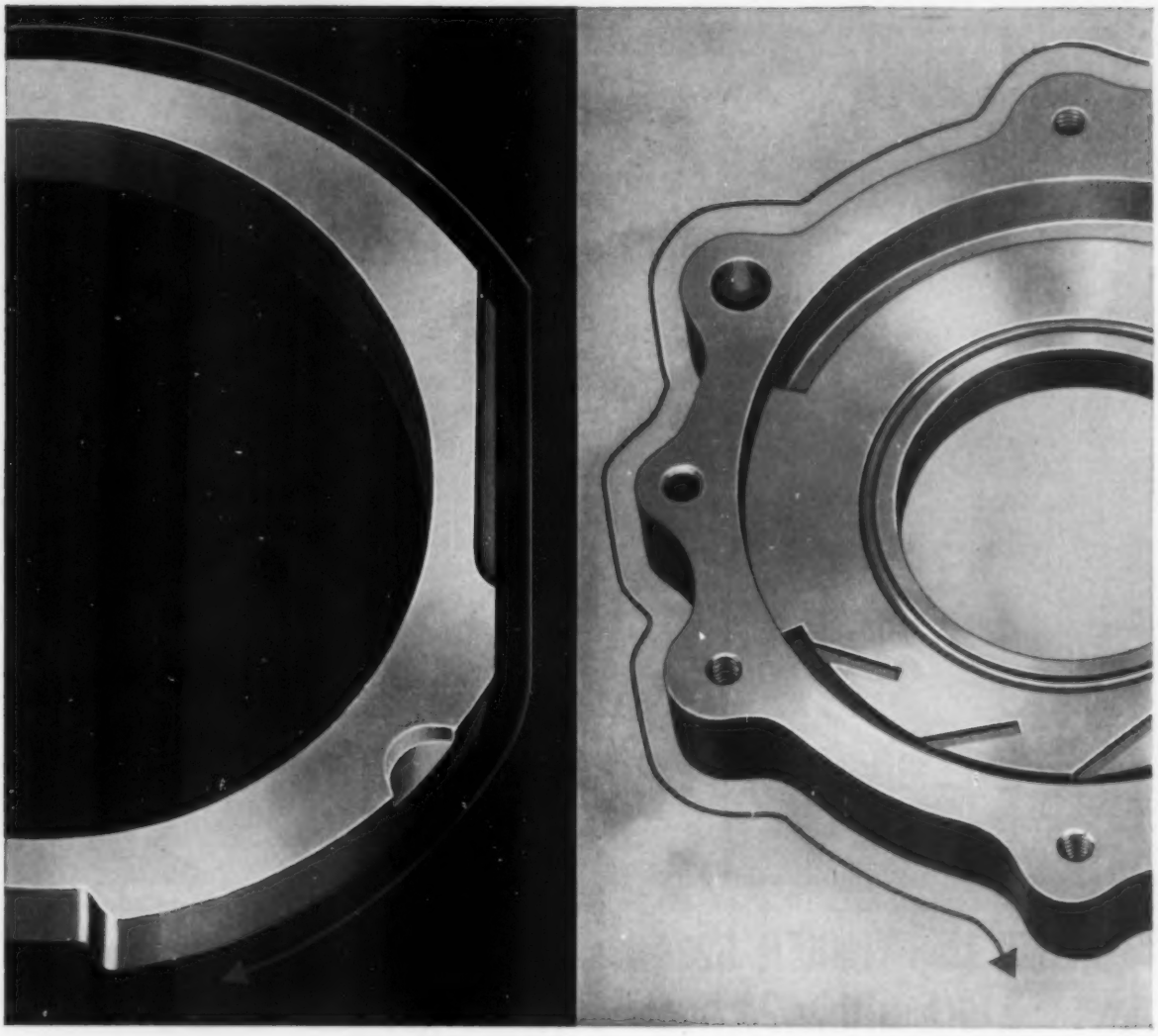
UNBRAKO®

SOCKET SCREW DIVISION

STANDARD PRESSED STEEL CO.

SPS

JENKINTOWN PENNSYLVANIA



Does *complexity* limit use of metal powder?

One shape is simple, the other complex. And while these parts have widely different applications and performance characteristics, *both* were easily produced from metal powder.

Costs were cut because each part could be mass-produced in a single press operation. Yet, closer-than-ever tolerances were maintained.

Moraine Products has the experience gained from the production of hundreds of millions of metal powder parts in an infinite variety of shapes and sizes. This experience and our familiarity with other types of production processes guide our engineers in determining whether our materials and our processes are best suited to the production of a specific part.

When we accept a job to make metal powder parts, it is only after thorough study has shown that the customer will receive parts of the highest uniform quality for dependable end-product performance. Of course, on-time delivery is assured regardless of quantity.

Moraine Products also produces: Moraine Power Brakes—Delco hydraulic brake fluids, brake assemblies, master cylinders, wheel cylinders, and parts—Moraine friction materials—Moraine-400 and M-100 automotive engine bearings—self-lubricating bearings and porous metal filters—rolled bronze and bi-metal bushings.

Another General Motors Value

Moraine Products
Division of General Motors, Dayton, Ohio

Need hollow parts stock FAST?

We'll ship TIMKEN® 52100 steel tubing from warehouse stock within 24 hours after we get your order!

NEXT time you have a *rush* hollow parts job, call on us! Timken® 52100 steel tubing is ideal for making hollow parts—and we'll ship it quickly. Order less-than-mill quantities of 52100 tubing *today*, and it'll be on the way *tomorrow*.

Timken 52100 steel tubing ranges in O.D. from 1" to 10½". It's a through-hardening steel in moderate sections, can be heat treated to file hardness, tempered back as you desire. Quite often, Timken 52100 steel tubing can be substituted for costlier steels.

That's why it's so widely used—in aircraft parts, ball bearing races, pump parts and plungers, collets, bushings, spindles, grinding machine parts, precision instruments, dozens of other parts.

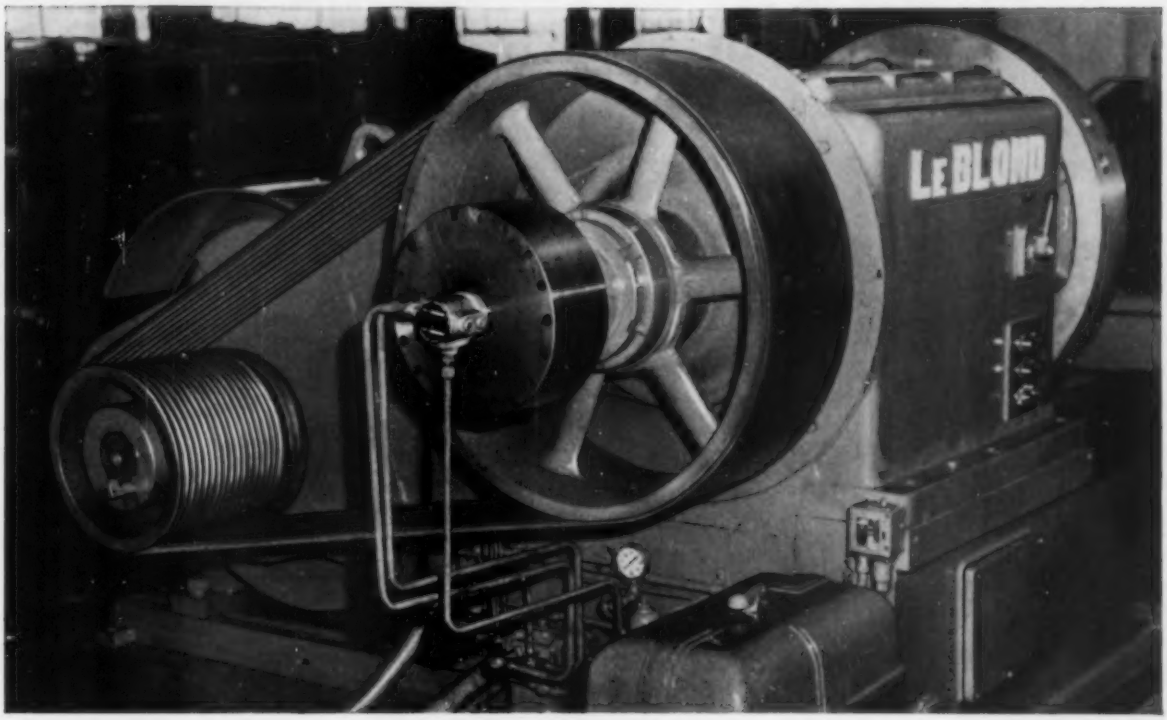
We're America's pioneer producer of 52100 tubing, and the only company that makes 52100 steel in tubing, bars and wire. We can assure you of uniform quality from *tube* to *tube*, from heat to heat and from *order* to *order*.

So, if you're in a rush for less-than-mill quantities, write, wire or phone: The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable address: "TIMROSCO".

TIMKEN *Fine Alloy* STEEL

TRADE-MARK REG. U.S. PAT. OFF.

SPECIALISTS IN FINE ALLOY STEELS, GRAPHITIC TOOL STEELS AND SEAMLESS STEEL TUBING



NEW R/M *Poly-V*® *Drive*

Solves Seven Major Power Transmission Problems!

Heavy duty drive problems can be accepted as necessary and costly features of power driven equipment—or they can be overcome! The difference is Poly-V* Drive . . . R/M's patented new concept in heavy duty power transmission. Here's how R/M Poly-V Drive helps eliminate seven major problems common to most conventional V-belt drive applications.

BELT MATCHING—Poly-V employs a single unit, V-ribbed endless belt running on specially designed sheaves—not a series of V-belts which vary in length. Belt length matching problems are completely eliminated!

SPEED RATIOS—Full contact between belt ribs and sheave grooves prevents belt "sinking" and uneven speeds . . . maintains constant speed ratios and effective pitch diameter from *no* load to *full* load!

SPACE REQUIREMENTS—Greater horsepower capacity per inch of sheave width with Poly-V delivers up to 50% more power in the *same* space as a multiple V-belt drive . . . or *equal* power in as little as ⅔ the space!

DRIVE LIFE—Poly-V Drive has *twice* the contact area with only *half* the face pressure and that means *less* wear, *longer* life for both belt *and* sheaves!

STOCK INVENTORIES—Just *two* cross sections of Poly-V Belt meet *every* heavy duty power transmission requirement, as compared to *five* in the case of V-belts. With Poly-V you keep belt and sheave inventories to an all time low!

HEAT PROBLEMS—Because thinner Poly-V Belts have twice the ribbed area of V-belts exposed to the air, you are assured *cooler* operation and less strain on your equipment. And, of course, Poly-V Belt construction is heat resistant, oil-proof and non-spark!

EQUIPMENT DOWNTIME—Stronger, cooler running, longer lasting Poly-V Belt needs fewer tension adjustments after run-in . . . stays on the job longer to reduce downtime costs for replacements, too!

If any—or *all*—of these features can help improve your heavy duty power transmission drive performance and dependability, you owe it to yourself to investigate R/M Poly-V Drive. R/M engineers who developed it will be glad to assist you in determining the Poly-V Drive installation that will best solve your problems . . . give you "More Use per Dollar."

*Poly-V is a registered Raybestos-Manhattan trademark.

RM734

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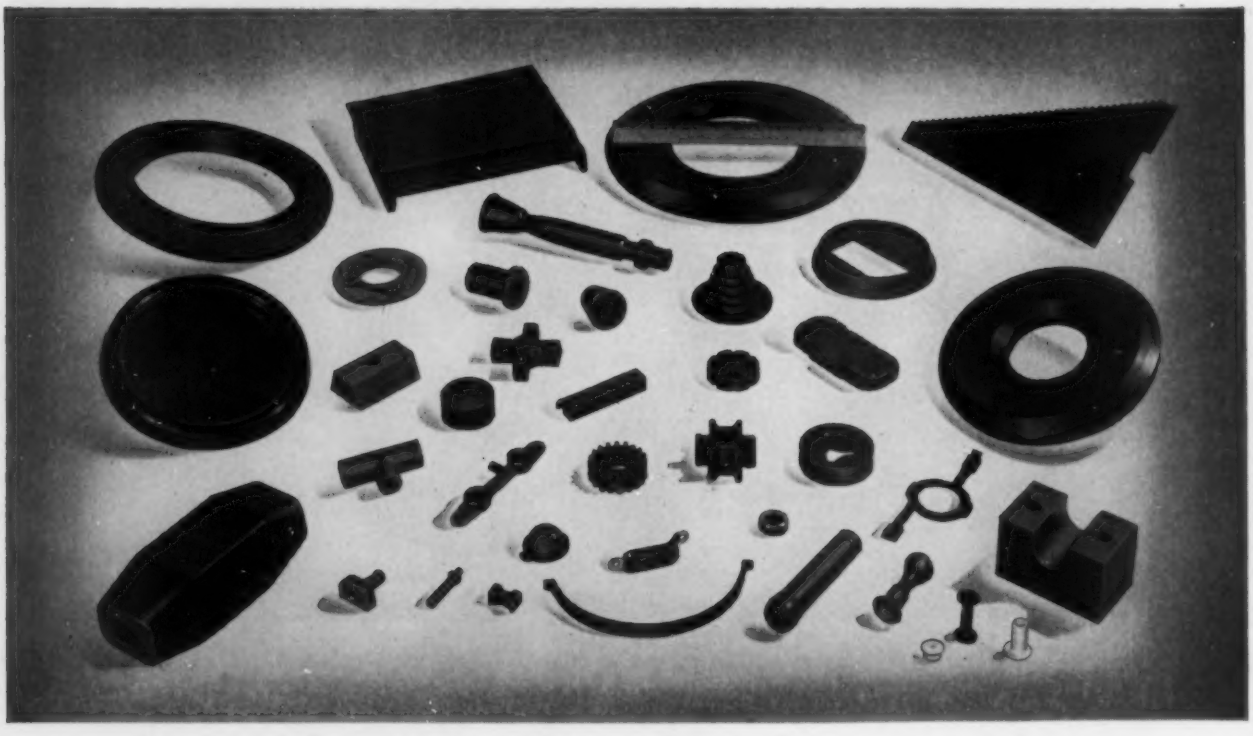
Other R/M products: Abrasive and Diamond Wheels • Brake Blocks and Linings • Clutch Facings • Asbestos Textiles • Mechanical Packings • Engineered Plastics • Sintered Metal Products • Industrial Adhesives • Laundry Pads and Covers • Bowling Balls

CALL ON R/M ENGINEERING SERVICE



R/M MOLDED PARTS—Custom-Engineered in RUBBER • SILICONE

Correct design and material of component parts can prove the solution to difficult product problems. Custom-Engineering molded parts to meet specific applications has been a specialty at Manhattan for over 60 years. R/M engineers design molded parts to meet new product requirements. They develop improved parts to overcome troublesome conditions or high production costs caused by parts and materials currently in use.

Natural rubber may be the best choice for your product components. Perhaps operating conditions dictate the use of an oil-proof or chemically resistant synthetic rubber. Or analysis of your requirements may suggest silicone will do a better job. R/M specialists will help you determine the *best* material . . . and follow through with the *best* design to assure long, trouble-free service regardless of temperature or other conditions. Manhattan's modern facilities for quality control, inspection, flash removal and precision manufacturing equipment give you the added advantage of low cost, mass production methods. You get the custom-engineered parts you need . . . delivered *in time* to meet production schedules.

The same engineering and production quality goes into cut and extruded parts made by R/M to your special order, as well as Parock oilless bearings for submerged light duty in any solution not harmful to rubber. Wherever your design calls for industrial rubber products . . . R/M hose, conveyor belts, transmission and V-belts, and R/M's new concept in power transmission, the Poly-V® Drive, as well as molded parts, offer the practical solution to your design and cost problems. Let R/M specialists work with you.

**Poly-V is a registered Raybestos-Manhattan trademark.*

For booklet shown, or other data, write, phone or wire:

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Raybestos-Manhattan, Inc.
Passaic, N.J.
GRegory 3-2000

R/M

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FOR HELP IN SOLVING YOUR PROBLEMS

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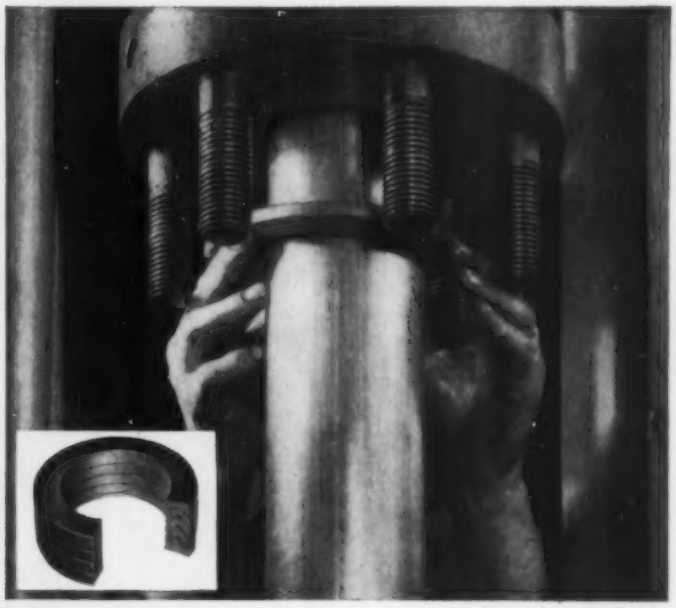
for top performance under pressure

R/M Vee-Flex, the original convex-design hydraulic packing, is the best yet developed for tough applications. It is designed for every piston and rod, and is automatically self-sealing and self-adjusting, even at pressures of 6000 psi and above. Other features include precision molding and trimming; deep, thorough penetration of the compound into the fabric; rock-hard adapters to resist high pressures and to prevent extrusion.

If you have a packing problem, call on R/M's specialized packing engineering service. R/M makes a complete line of mechanical packings, and can also meet your requirements for "Teflon"* products and asbestos textiles.

**A Du Pont trade mark*



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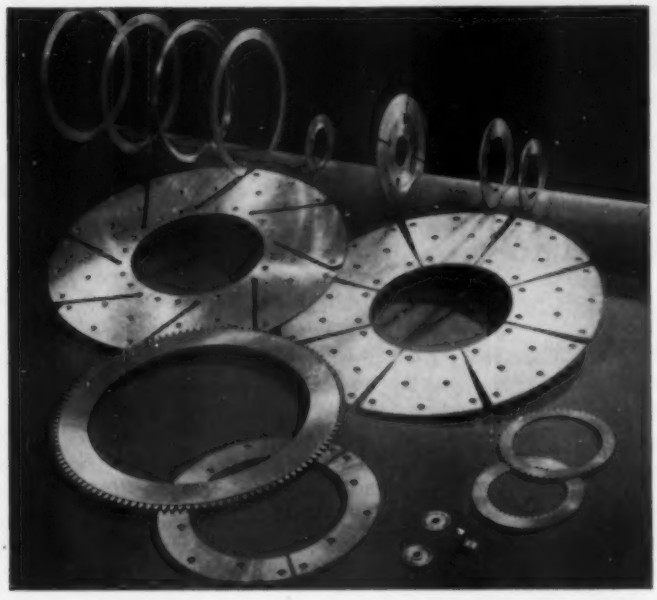

SINTERED METAL Friction Parts

Wherever high temperatures, close tolerances, or rapid repetitive engagement is a factor, R/M sintered metal friction parts may outperform asbestos. With their high thermal conductivity and absence of a destructible bond, sintered metals can give you greater output and longer wear.

This helps point up the advantage of turning any friction problem over to R/M. Unlike other manufacturers, R/M works with *all* kinds of friction materials ... from sintered metal to woven and molded asbestos, cork-cellulose and semi-metallic. So you can be sure of a completely unbiased recommendation whenever you consult an R/M engineer.

Write for your copy of R/M Bulletin No. 500. It's loaded with practical design and engineering data on all R/M friction materials.

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Rubber Lined and Covered Equipment

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Industrial Adhesives

Teflon Tape, Packings, Sheets, Rods, Tubes

Engineered Molded Rubber and Plastics

Cross section shows sealing edges at (A) inside of container nozzle; (B) top of nozzle; and (C) under bead of nozzle. Closure also seats deeply in mouth, to further prevent leakage.

West Penn Closure Corp., Warren, Pennsylvania, wanted a leakproof seal that could be easily applied by high-speed machinery . . . serve as a dispenser as well as stopper . . . and be practically indestructible.

They found the answer in a polyethylene spout with three different sealing edges, and a self-threading urea cap which formed a tight, yet easily removed top. And they found that Sylvania could hold their required tolerances and produce them in high volume.

West Penn created a leakproof closure ...Sylvania custom-molded it

LIGHTER FLUID, oil and other penetrating liquids, to be effectively packaged, call for a container closure with an extremely tight seal.

Custom molding of intricate parts like this is just one of the reasons leading manufacturers, large and small, come to Sylvania for consultation on parts designs.

Sylvania's Parts Division offers complete facilities for custom metal stampings, special electronic components and special wires. For complete details of these services, write for the "Portfolio of 4-way Service to Designers."

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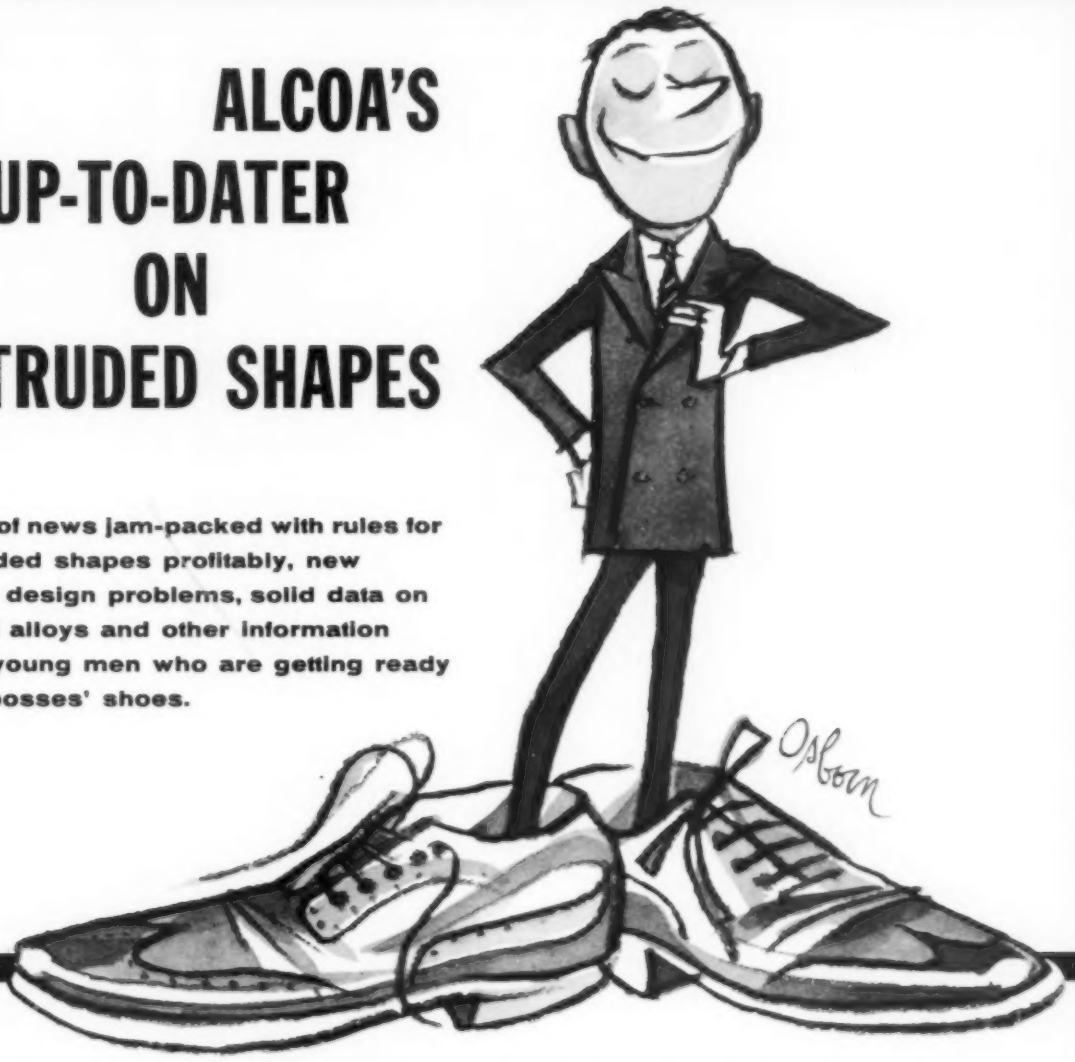
ALCOA'S UP-TO-DATER ON EXTRUDED SHAPES

Four pages of news jam-packed with rules for using extruded shapes profitably, new solutions to design problems, solid data on costs, latest alloys and other information for today's young men who are getting ready to fill their bosses' shoes.



here's the rule book for using extruded shapes to save time, trouble, money.

In a nutshell, the biggest rule is: when you have a complicated cross section, it can usually be made as an extruded shape—and much more economically. Then, too, an Alcoa® Extruded Shape adds strength without adding weight. It cuts out welding, roll forming, riveting and eliminates costly machining. Here's how:

1. Instead of using standard rolled shapes such as angles or I beams, consider a made-to-your-design extruded shape. It allows you to put the metal right where you want it and need it. Take a long column, for instance. An extruded shape with a cross section like a capital C will support almost twice the load as will a standard channel of the same dimensions—and with less metal. Weighs less, too. Frees your imagination from standard shapes.

2. If you're building up sections using welded, riveted or crimped construction, take a hard, cost-reducing look at extruded shapes. Eliminate cost-increasing assembly work, cut out the chance for human error, save the money spent for jigs or crimpers.

3. If you're machining bars or rod into special angles, T beams, or other special long shapes, extrusions can be far less costly. Time-killing, costly machining is gone—so is scrap generation.

4. If you've got a small part with a cross section that can be drawn in one plane, it can be extruded even if it's complicated. Lots of them can be made at one time in the long length. Then, the pieces are just sawed off, like slicing bread.

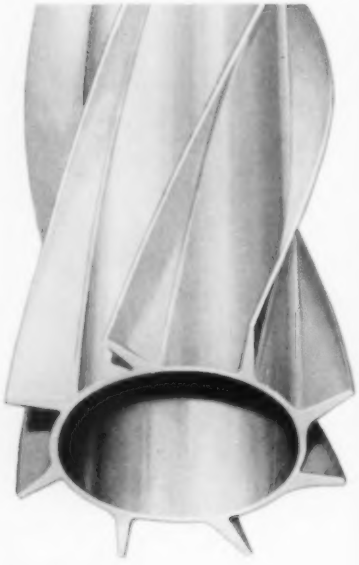
If you can doodle it, we can do it. If you can sketch the cross section, we can extrude it. All we need to start helping you is your sketch and invite.

if you can doodle it, we can do it.

advertisement

What's new in problem solving?

Virtually every shape extruded in our five extrusion plants is new—a problem solver to a designer and his company. Across the top of the page are a few recent examples that we think interesting. Use them as idea starters.

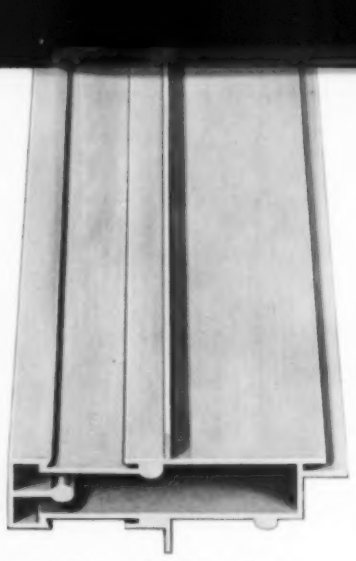


corkscrew extruded: spiral ribs

Here's an interesting extruded shape—a hollow tube with eight ribs spiraling down the outside. (We are making six- and 12-rib ones, too). It comes out in a long tube 20 feet long, six in. in dia. Alcoa's diemakers and extrusion experts worked it out so the extrusion actually spirals out of the die.

extruded sunshades

Here's another special architectural shape, used for louvers or sunshades that are electrically operated and clock controlled to follow the movement of the sun. They run vertically over window walls. Light weight, high reflectivity, beauty, natural resistance to weather, are reasons why aluminum is the metal. For economy, Alcoa extrudes in three pieces, which are dovetailed together during erection to make a louver 12 in. wide, 1½ in. thick. Walls are 0.063 in. thick.



complex extruded shape: special stool

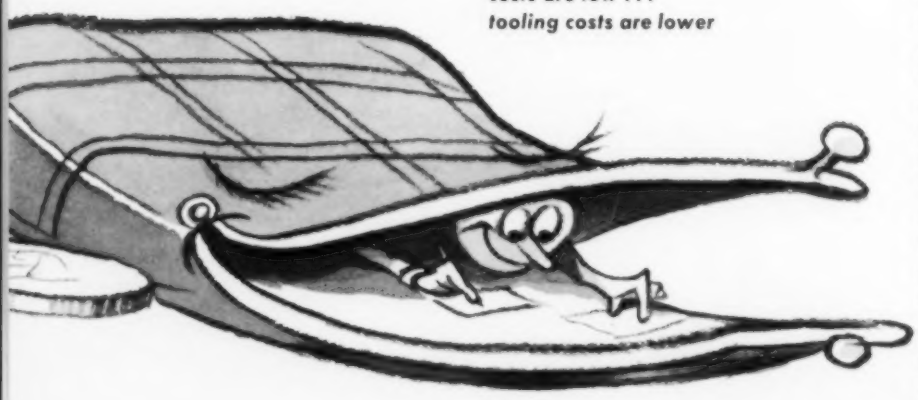
Typical of the many special architectural shapes is this special 5½-in.-wide "stool," a horizontal member used in a curtain wall building. Top slot takes the glass panel stop; bottom one, the aluminum panel stop. Inner key with knob is made with special tolerance of ± 0.005 in., takes fastener from vertical member. An extruded shape is the only practical way to make it. Bright, clean, rustproof Alcoa Extruded Shapes are universally used in building design. And color—an integral part of the metal surface—can be added. Maybe your shape isn't as complicated as this part, but we bet this example starts your imagination running.

Costs?....

When a designer turns to extruded shapes for the first time, he's sure costs are going up. Usually, he's looking at extrusions because he thinks his part would be impossible to make any other way—or because its costs are great in fabrication assembly. It's always a big, pleasant surprise when he finds out that base costs are low. Tooling for an extruded shape is usually less than it is for other fabrication methods—casting, forging, stamping, special roll forming, or full machining.

Die charges for average solid shapes: one fitting inside a 3-in. dia. circumscribing circle—a

costs are low . . . tooling costs are lower



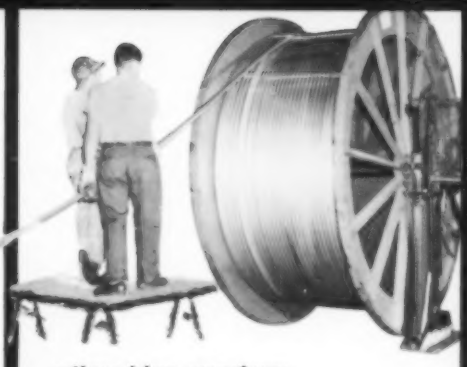
corner post: steel, 6¼ lbs/ft; aluminum, 2½ lbs/ft

Here's a special truck-body shape used as a vertical corner post. It replaces a formed steel post. In steel, it weighs 6¼ lbs / ft; rustproof Alcoa Aluminum Extruded Shape: 2½ lbs / ft. Cost and strength about the same. It's easier to handle during assembly. When used as roof rail, it is available in one long length. In steel, the forming tool limited the length, making welding necessary. Better check on the cost-reducing possibilities in your rolled steel forms. Many designers are turning to structurals extruded by Alcoa—reasons: rustproof, light, strong, available.

extruded 1,000 feet long

We're often asked how long and big an extrusion can be. 10-30 feet is usual, although that is often exceeded; 110 feet and more is possible.

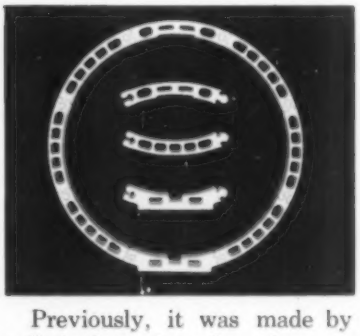
Here's an extra-long one, 1,000 feet. It's 2-in. dia. cable sheathing, continuously extruded by Alcoa in a piece almost 1/5 of a mile long. Alcoa research and improved manufacturing methods made it possible. It's coiled on big reels, shipped to the cable plant where it is drawn over the conductor. Replaces a lead application because of price, weight, availability, strength.



other idea sparkers

Other unusual extrusions that may spark an idea: wide integrally stiffened, ribbed panels that are extruded as a "V" configuration, then flattened and processed to make a wider panel than the presses could make. The 14,000-ton press makes pieces 40 in. wide by this method. Another reason for "V" construction: costs are partly dependent on the size of the circumscribing circle. Also a "V" shape can be made on a smaller press than would be needed if it was extruded flat. Dovetail, tongue and groove, shiplap, offset couplings, snap-fit joints are ways to multiply width without multiplying costs.

Alcoa often extrudes ribbed panels in narrow width components to cut costs and obtain thinner panel cross sections. Then they are roll-locked (up to 24 in. wide) prior to delivery. Shapes, extruded in sections to interlock with each other, are commonplace cost cutters in our plants. Here's a "for instance." Eight special shapes, 1½ in. thick, dovetail together to make a complex 20-ft tube, 23½ in. in dia.



Previously, it was made by rolled plate riveted up into an assembly. Cost, when made as Alcoa Extruded Shapes, was slashed tremendously.

. . . here's the factual story

little over $100; inside a 6-in. dia. circle—less than $400. Semihollow and hollow shapes run higher.

Other cost factors: shapes cost more as they get thinner; the further you go from a symmetrical shape, the higher the cost. Sometimes, the higher cost per pound of a thin section makes sense economically since the real cost is per foot or piece.

standard stocked shapes and dies

So far, we've been talking about special shapes to your designs, but that's not the whole picture. Alcoa maintains stocks of many standard shapes at its distributors around the country—angles, bars, channels, H beams, I beams, tees, zees, etc. Hence, shapes, with high mechanical properties and smooth, bright finish obtained by extruding, can be had quickly—and without die charges. Certain architectural, truck-body and aircraft shapes are also stocked at distributors. Also standard (without charge) dies are maintained at the plants and available for mill production. Information on stocked shapes and available dies is as close as your phone. Use it to call your Alcoa sales engineer.

advertisement

small parts...dozens at a time

Often, small parts with one-plane cross sections can be made cheaply by extruding long lengths and then wacking off the parts. They are just sliced off like bread. Torque converter blades are a good example. They have a special tolerance of ± .002 in. on the ordinates. Individual blades are cut off from long extrusions (they look like longitudinal slices of bent teardrops). Then they're tumbled, drilled and pin-installed on the stator or turbine. Previous method was milling from bar stock. Costs and scrap loss are cut.

what's new in alloys?

Biggest news is the availability of super-strength, hard alloys 7178 and X7079 for extruded shapes. Aircraft and missile designers are giving them their biggest play. Alloys 7178 and X7079 are a lot harder to extrude, a burden to the die designer . . . so costs are up. But so are the properties.

Here's a handy table of mechanical properties of the normal extrusion alloys in usual tempers. Where a range is given, properties depend on certain factors (thickness, area, etc.). To find out the properties possible with your design, check your Alcoa sales engineer. For any help on the proper alloy for your best balance between performance and costs, he is your great aid. Let him counsel with you.

Extrusion Alloys, Minimum Mechanical Properties

Alloy	Temper	Ultimate Strength psi	Yield Strength psi	Elongation % in 2"
3003	0	—	19,000	25
2014	0	18,000	30,000	12
	T4	35,000	50,000	12
	T6	53 to 58,000	60 to 68,000	6-7
2024	0	19,000	35,000	12
	T4	42 to 52,000	57 to 70,000	8-12
6061	0	16,000	22,000	16
	T4	16,000	26,000	16
	T6	35,000	38,000	10
6062	0	16,000	22,000	16
	T4	16,000	26,000	16
	T6	35,000	38,000	10
6063	T4	10,000 (1)	22,000 (1)	14 (1)
	T42	10,000 (1)	17,000 (1)	12 (1)
	T5	16,000 (1)	22,000 (1)	8 (1)
	T6	25,000 (1)	30,000 (1)	8-10 (1)
7075	0	24,000	40,000	10
	T6	68 ot 72,000 (2)	78 to 80,000 (2)	6-7 (2)

(1) 0.500 in. and less, thickness
(2) 5.000 in. and less, thickness; maximum areas 32 sq in.

cry to the designer:
up performance,
down costs,
beat competition

straight talk

Today's big cry to the designer is: up performance, down costs, beat competition. Often, his answer lies in Alcoa Extruded Shapes. The way to start? Call your Alcoa sales engineer. He's listed under "Aluminum" in the Yellow Pages. He can contribute good, solid technical thinking at any stage of your project. The best time to call him in is at the "pre-drawing board" or "doodle" stage. Use him—that's his job.

He'll have a copy of the new booklet, *Alcoa Aluminum Extruded Shapes*, under his arm for you. It's packed full of technical data and tables to make your work lighter. If your work is in aircraft, involves really big extrusions, or extremely thin sections, he'll trot out your copy of Alcoa's new 36-page design book on the design horizons opened by the 14,000-ton press. Or write for your copy of either booklet; better yet, write for both. ALUMINUM COMPANY OF AMERICA, 1909-C Alcoa Building, Pittsburgh 19, Pa.

ALCOA ALUMINUM
EXTRUDED SHAPES

Your Guide to the Best in Aluminum Value

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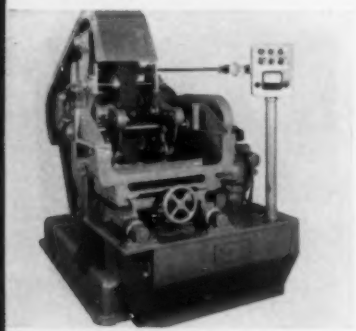
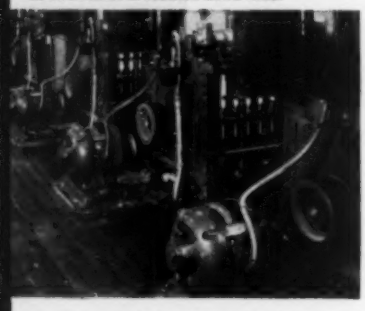
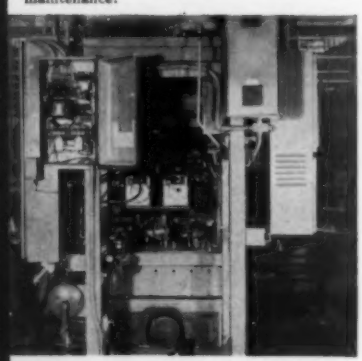


GRINDING MACHINES with DYNAC produce more because of reduced down time.



SPINNING FRAMES with DYNAC have saved owners over $3,000 per year per 100 frames.

CONVEYORS using DYNAC can be stopped once a minute, day in and day out, with no maintenance.



AUTOMATIC WELDERS with DYNAC can complete 600 operations per hour—20 stops per minute—24 hours a day.

problem: High machining cost
Abnormal scrap rejection

Solution:

AmForge Adaption Analysis

Your forging problem is our business. Enthusiastic engineers at AmForge consider each project a new challenge—a challenge to *adapt* AmForge facilities and know-how to your problem. For example, the axle-part forging for truck trailers above was once made as a casting. Although the design more readily adapted itself to casting methods, it was proved that it could be forged. The result was more uniformity, reduced machining hours and less scrap. Being stronger as a forging, the net weight of the part was reduced, resulting in greater payloads with lower maintenance cost for the truckers. Ask us for an AmForge Adaption Analysis. Phone, write or send the coupon.

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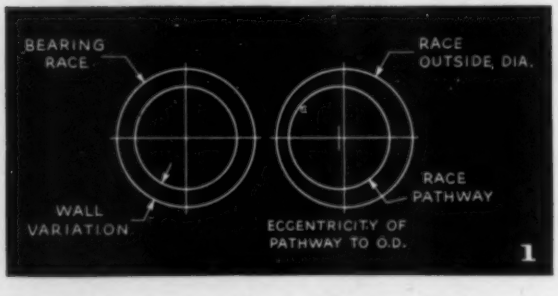
The Inside Secrets of Smoother Performance

How HYATT quality controls assure race concentricity, roller diameter uniformity and other internal essentials of smoother, longer-lived cylindrical roller bearings . . .

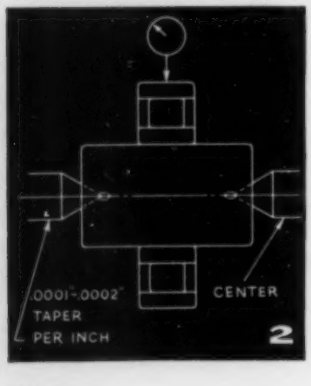
The running accuracy and smoothness of a roller bearing is governed primarily by its internal dimensions and clearances. The most important of these are:

1. CONCENTRICITY OF RACE DIAMETERS

Eccentricity of race diameters is usually interpreted in terms of *wall variation*, Figure 1, on the individual components and in terms of *radial run-out* on the assembled bearing. The



assembled bearing is usually mounted on an arbor, Figure 2, having a slight taper (.0001″ to .0002″ on the diameter per inch of length) and the radial run-out indicated as shown. The radial run-out is the difference between the minimum and maximum readings obtained when rotating the outer race one revolution with the arbor stationary for outer race radial run-out, or rotating the arbor one revolution with the outer race stationary for inner race radial run-out.

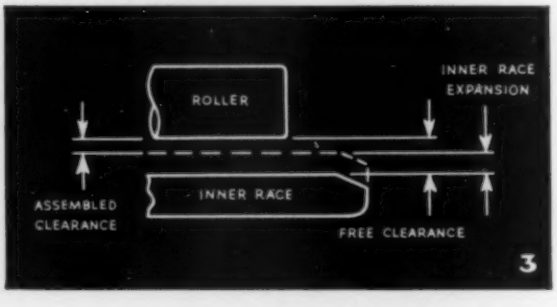


2. UNIFORMITY OF ROLLER DIAMETERS

Another factor governing running smoothness is *roller diameter uniformity*. This is usually obtained by segregating the rollers into diameter variation classes of .00005″, .0001″, or .00015″, depending on the bearing size and the nature of the application, and assembling only rollers of the same group into a given bearing. Gauging for this segregation necessarily rejects excessive taper.

Uniformity of roller diameters is important for another purpose. It provides the user with a bearing in which the internal diametral clearance is controlled within the closest possible limits. The rollers are matched with races which are segregated for pathway size in a fashion similar to the rollers, usually to twice the diameter limits of the rollers. The internal clearance can thus be manipulated at will by combining various diameter classes of races and rollers; but once a particular range is selected, it will remain constant within the combined limits of the roller and race pathway diameter limits. Here, again, a tapered condition of the race pathway is automatically rejected.

Obviously, the internal clearances of commercial bearings must be standardized for the practical reasons of cost and availability, but the clearance values have been so selected that under the specified fits the *running* clearance is at the most desirable minimum, depending on bearing type and size. Figure 3 (magnified).

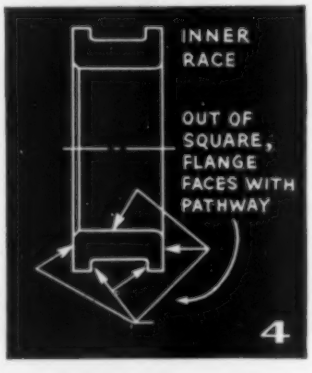


Checking wall variation, flange run-out and race end squareness on combination gauge.

3. SQUARENESS OF ROLLER ENDS AND FLANGE FACES

One other tolerance that contributes to the running efficiency of HYATT Hy-Load Series Bearings of the flanged race type is the *squareness of roller ends with roller diameters* and the *squareness of flange faces with the race pathways.*

Flanged race bearings are commonly used for locating shafts laterally and for running conditions of light and intermittent thrust load. For best operating results, the ends of the rollers must be flat and square with the diameter within a matter of tenths. The lateral clearance between the roller and the race shoulders must also be held to a minimum. This means close tolerances on roller length and race pathway width, and the flange face, Figure 4, must be square with the roller pathway. When all these conditions are satisfied, there will be no tendency for the rollers to skew and raise the operating temperature of the bearing, nor will there be any unusual force on the separator or cage with a tendency toward wracking and noisy operation.



The *side run-out* of the individual races or the *out-of-square* of the ends with the fitting diameters is also important, especially in applications where a number of parts are held together endwise and where the pressure might be sufficient to tilt the race, creating a condition of excessive taper on the roller pathway with consequent roller skewing and the development of excessive heat and noise.

All these internal dimensions and clearances are so carefully controlled that HYATT Hy-Roll Bearings have built an unsurpassed reputation among design engineers for exceptionally long, smooth and trouble-free performance.

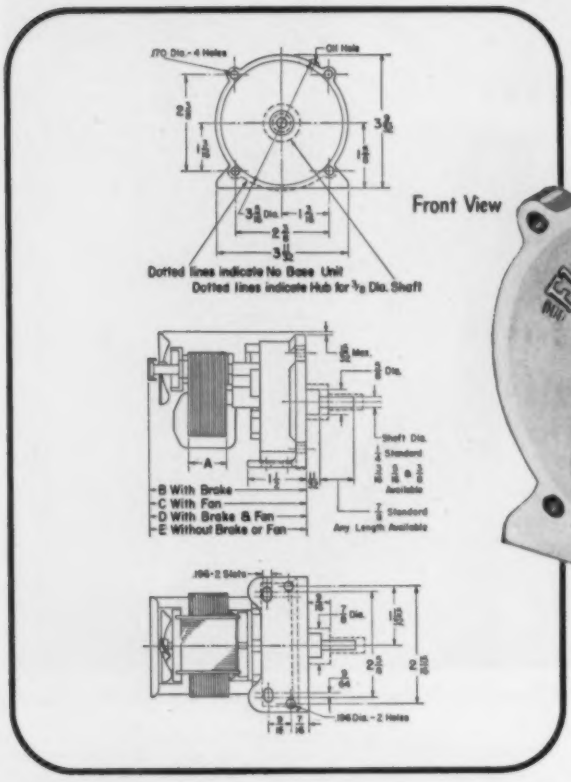
YOU WILL FIND MORE DETAILS

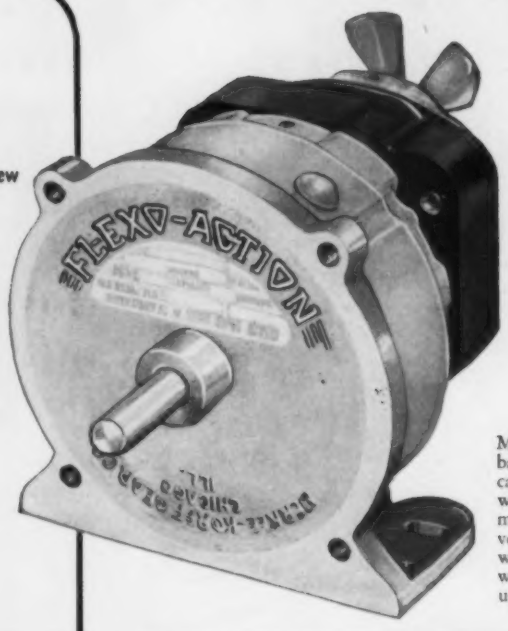
in HYATT General Catalog No. 150, or your nearby HYATT Sales Engineer will gladly help you choose the type best suited to your design requirements. Remember, HYATT is America's first and foremost maker of cylindrical roller bearings. Hyatt Bearings Division of General Motors Corporation, Harrison, New Jersey.

GM GENERAL MOTORS

HYATT *HY-ROLL BEARINGS* FOR MODERN INDUSTRY

POWER UNDER CONTROL


Front View
Dotted lines indicate No Base Unit
Dotted lines indicate Hub for 3/8 Dia. Shaft
B With Brake
C With Fan
D With Brake & Fan
E Without Brake or Fan
Any Length Available



Model SG25 with base case. This unit can also be furnished with no base for face mounting, with inverted base, or side wall mounting, or with shaft vertically upward.

Stator Thickness and Corresponding Length				
A	B	C	D	E
9/16	3 1/8	3 1/4	3 9/16	2 7/8
13/16	3 1/2	3 7/8	3 13/16	3 1/4
1 1/2	4 7/16	4 3/4	4 13/16	4 1/4

How To Buy the Right Geared Motor for Your Job

Measure the speed and torque required when possible. If torque can't be measured make a realistic estimate. Buying a motor that is too strong can be just as harmful as buying one that is too weak.

Be sure to specify direction of rotation, if uni-directional, or reversing if required. Will the motor operate continuously or is the duty cycle intermittent? Specify the type motor required for the job—whether induction or synchronous, AC, DC or universal.

Experienced Merkle-Korff application engineers can assist you in choosing the right unit for the job. They will recommend a fractional horsepower geared motor with an ample margin of safety to meet overload or low voltage conditions.

Merkle-Korff has been building a product of proven quality for years and can deliver motors *on time* to fit your production schedule.

A typical torque table is shown. This table shows no-load speeds for uni-directional shaded pole induction motors. The loads are the maximum under which the motor will start and operate continuously without over-load. The speeds shown are those commonly used. If the maximum rated torque is required at speeds greater than shown, modifications can usually be made. Units can be furnished at speeds as low as 1 RPH or slower.

Merkle-Korff builds a varied line of fractional horsepower geared motors. For detailed dimension drawings, mounting styles and torque tables of the complete line, write for engineering data sheet PE2.

TORQUE TABLE - LB. IN.
MODEL SG-25

rpm	stator thickness and torque		
	9/16"	13/16"	1 1/2"
300	1.2	1.5	3.0
150	2.3	3.0	6.0
100	3.5	4.5	9.0
60	6.0	7.5	15.0
45	6.6	9.0	17.0
30	10.0	13.0	26.0
25	12.0	16.0	30.0*
20	15.0	20.0	"
15	20.0	26.0	"
12	25.0	30.0*	"
10	30.0	"	"

* At these speeds and lower the units will deliver more torque than is shown on the tables. The output shaft should not be loaded above the value shown on the table. This is the rated capacity of the gear case.

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GARLOCK and Announce

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Now, the United States Gasket Company will be known as the United States Gasket Company, Plastics Division of The Garlock Packing Company.

In August 1955 Garlock acquired the United States Gasket Company. Subsequently, the production facilities of both companies were integrated. Now, it is clear that the customers of both companies will be better served through an integrated sales force.

Better Service for Customers

Both U.S.G. and Garlock customers will now enjoy the finest, most complete service available in the fields of fluorocarbons (Teflon* and Kel-F**), nylon and other plastics as well as mechanical packings and seals of all types. Specialists in specific materials and applications will always be available for consultation on your problems.

Saves You Time

This integration of sales forces will also simplify your purchasing problem . . . you can standardize on one reliable source of supply and have more time to devote to other important problems.

Unbiased Recommendations

With the addition of U.S.G. plastic products to the famous "Garlock 2,000" family of packings, gaskets, and seals, your local representative is able to supply the right seal for every conceivable need. Call him at the office nearest you.

30 Sales Offices

U.S.G. plastics specialists join the 125 Garlock salesmen at 30 sales offices and warehouses where large stocks of plastic products are stored. This means faster deliveries from local stocks, as well as expert plastics and sealing assistance as close as your telephone.

*DuPont Trademark
**M.W. Kellogg Trademark

Main Factory Buildings of The Garlock Packing Company, Palmyra, New York. Other factories in San Francisco and Canada.

One of the two Camden, N.J. plants of the United States Gasket Company, Plastics Division of The Garlock Packing Company

United States Gasket

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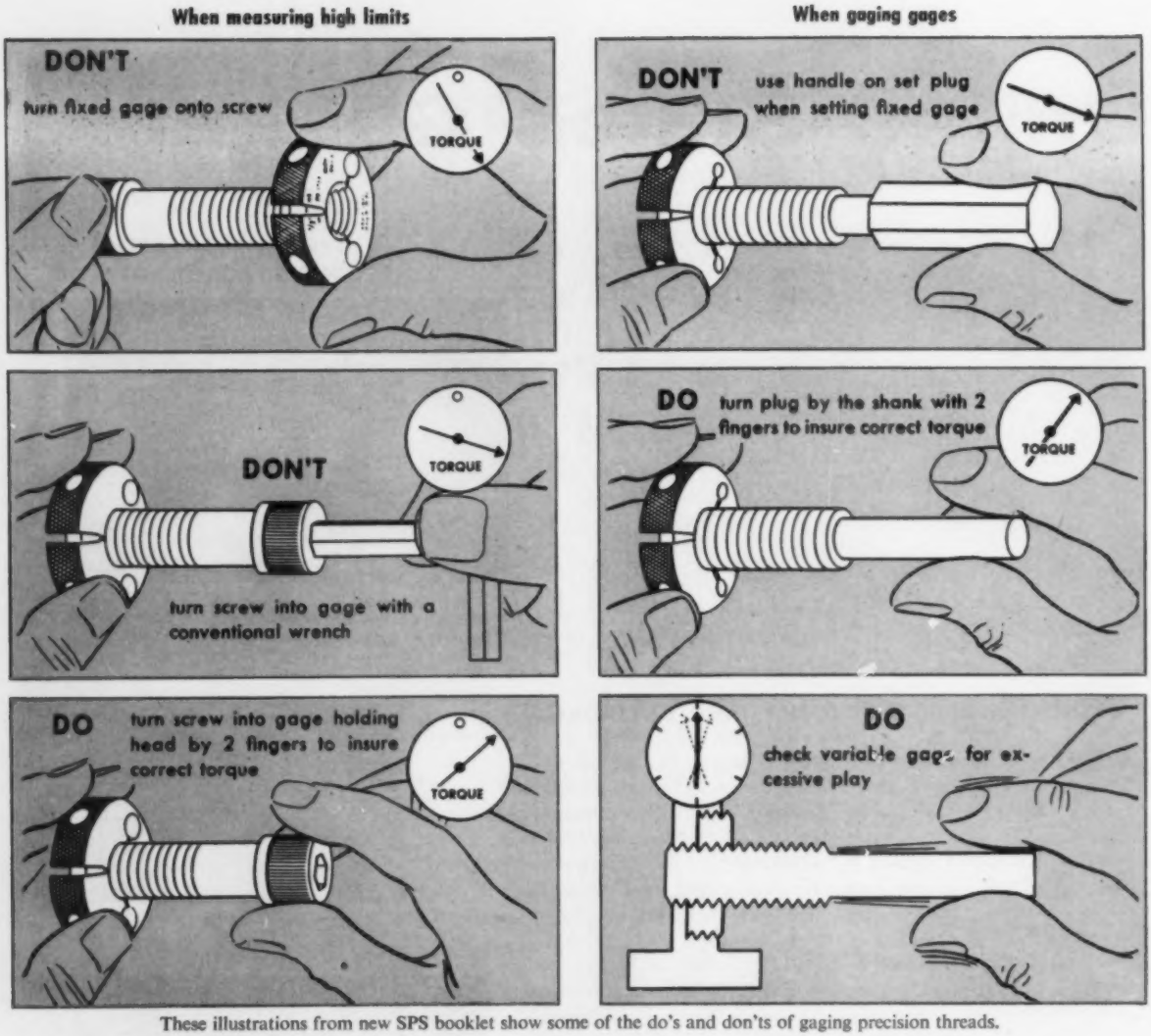

These illustrations from new SPS booklet show some of the do's and don'ts of gaging precision threads.

3A threads: what they are; how to gage them — new SPS booklet tells all

Threads made to Class 3A fit are the most precise in general use in industry. But you do not always get the 3A precision you specify. Because of many different gaging techniques that yield varying results, screws with threads well outside the Class 3A tolerance limits often pass inspection.

SPS has prepared a new booklet on this subject. It explains clearly what Class 3A threads are and the pros and cons involved in the widely varying gaging techniques in use today. It reviews the gaging of high and low limits of 3A threads, sampling techniques, and even the methods of gaging gages.

All standard UNBRAKO socket screw products fall within specified tolerance limits *no matter what method is used to gage them.* Leading industrial distributors carry complete stocks. Unbrako Socket Screw Division, STANDARD PRESSED STEEL Co., Jenkintown 28, Pa.

Form 2239, "Class 3A Threads: what they are; how to gage them." 16 pages, with many illustrations. Write for free copy today.

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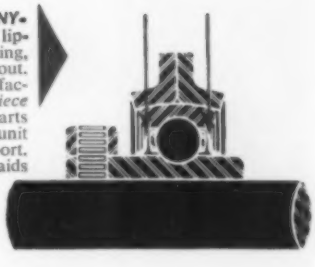
BEST SEAL AVAILABLE ANYWHERE! Synthetic rubber lip-type seal, integral with bearing, keeps lubricant in, dirt out. Bearing is greased at the factory and shipped in *one piece* . . . no juggling of sundry parts in assembly—simply slip unit on shaft and bolt to support. Its compactness further aids design flexibility.

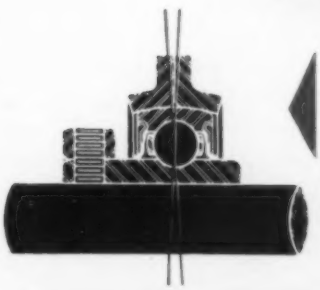


LINK-BELT JPS-200 ball bearings maintain capacity despite shaft and support deflection

In rugged field service, supporting structures on farm machinery and similar equipment undergo inevitable weaving. Shafts, too, are subject to dynamic deflections. Answer: *self-alignment* — the ability of Link-Belt bearings to adjust under these conditions. And it's yours *at low cost* in this precision Link-Belt ball bearing.

Equally important, Series JPS-200 bearings achieve their economy with *no loss of efficiency*. They combine sturdy pressed-steel housings with standard, full-capacity Link-Belt ball bearings.

Folder 2517 has complete data on the Link-Belt JPS bearing series, and Book 2550 covers the entire Link-Belt bearing line. Get both from any of 40 Link-Belt offices.



FREE ROLLING AND FULL LOAD CAPACITY are maintained even under shaft or support misalignment with Link-Belt self-aligning feature. Extra-long inner ring of bearing assures proper load distribution. Heavy spring-locking collar firmly secures bearing on shaft.

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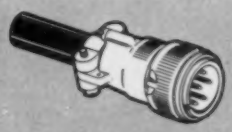

AN-E SERIES . . . environment resisting. Replaces AN-M. Meets Specification MIL-C-5015C. Resilient inserts. Integral cable clamp. New grounding lugs. Interfacial sealing, improved grommet and new grommet follower.

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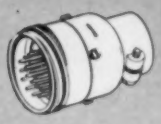

K, RK SERIES...**SPECIAL ACME THREAD.** The All-Purpose Series. Conduit and cable clamp entry types. 1 to 82 contacts in 213 different contact layouts. 10-, 15-, 30-, 40-, 60-, 80-, 115-, and 200-amp. silver-plated contacts. High quality phenolic, melamine, and formica insulators. Cadmium-plated aluminum alloy shells.

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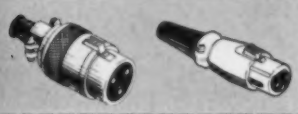
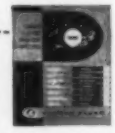


P, XLR, XL, XK, O, UA, BRS SERIES... many shell styles and insert layouts. Straight and angle 90° plugs. Latch-lock types. Wall-mounting, panel, locknut mounting, and adapter receptacles, single- and two-gang. 10- to 30-amp. contacts, coaxials. UA Series features 3 gold-plated contacts.



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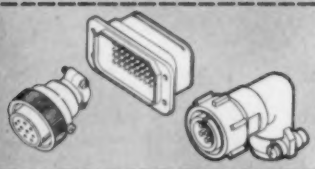

D, MC, DPA, DPX, AND K MINIATURES... miniatures and sub-miniatures designed for amplifiers, miniature indicators, computer circuits, telemetering equipment, small pre-amps, and general instrumentation where space is limited and current requirements are generally not over 5 amperes. Variety of shell styles, junction shell, and insert arrangements. 3 to 50 contacts, plus coaxials.

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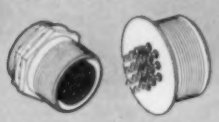

GS (AN TYPE), KH, RKH, DAH, BFH, TBFH, DBH, KH30... with steel shells and contacts to withstand high pressures from within or without. Insulation is a glass material, fused under high temperature to shell and contacts, thus forming a hermetic seal.

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AN-K, AN-"FW," AND CANNON K-"FW" STEEL SHELL CONNECTORS... Open flame protection offered in the greatest variety of this type of connector. Wall- or box-mounting receptacles. Straight or angle 90° plugs. Crimp-type contacts. Inserts of glass-filled materials.

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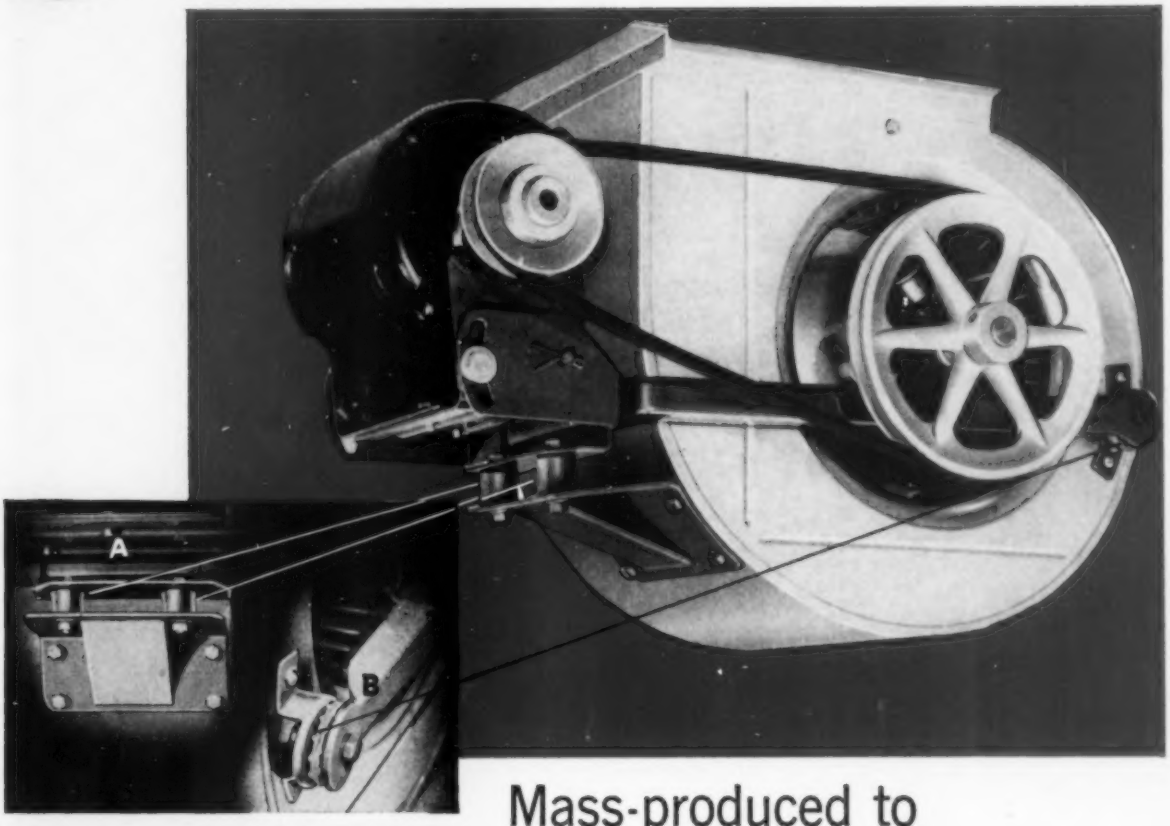

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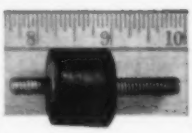

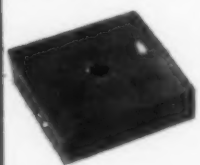

U. S. Molded Drop Forge Mounting in service for over 13 years—absorbed *80 million* blows of almost 1600 lbs. force each without wearing out—removed only when steel retaining pins had corroded.

U. S. Molded Diaphragm for controlling liquid flow through motor valves. Offers high burst resistance, retention of molded shape under high pressures, and exact fabric placement.

Mass-produced to exacting specifications

U. S. Rubber Molded Mountings and Connectors help keep blowers operating at "whisper silence".

A well-adjusted system for a forced warm air furnace requires that all vibration and noise be kept to an absolute minimum. In this leading "sulky" type blower, the entire moving parts assembly floats on a cushion of U. S. Molded Rubber Mounts (A) and firm, but movement-free, U. S. Rubber Finger-Flex Connectors (B). In this manner, all mechanical vibrations are isolated—the blower operates in silence.

U. S. Rubber Molded Mountings and Connectors were selected because of their ability to retain "molded in" shape during their entire long life and for the economy they provide.

Yet, this is only one of hundreds of applications wherein U. S. Engineered Rubber Products *do jobs no other material can do.* "U. S." engineers will help you solve any molded rubber problem. Contact us at Rockefeller Center, New York 20, N. Y. In Canada, Dominion Rubber Co., Ltd.

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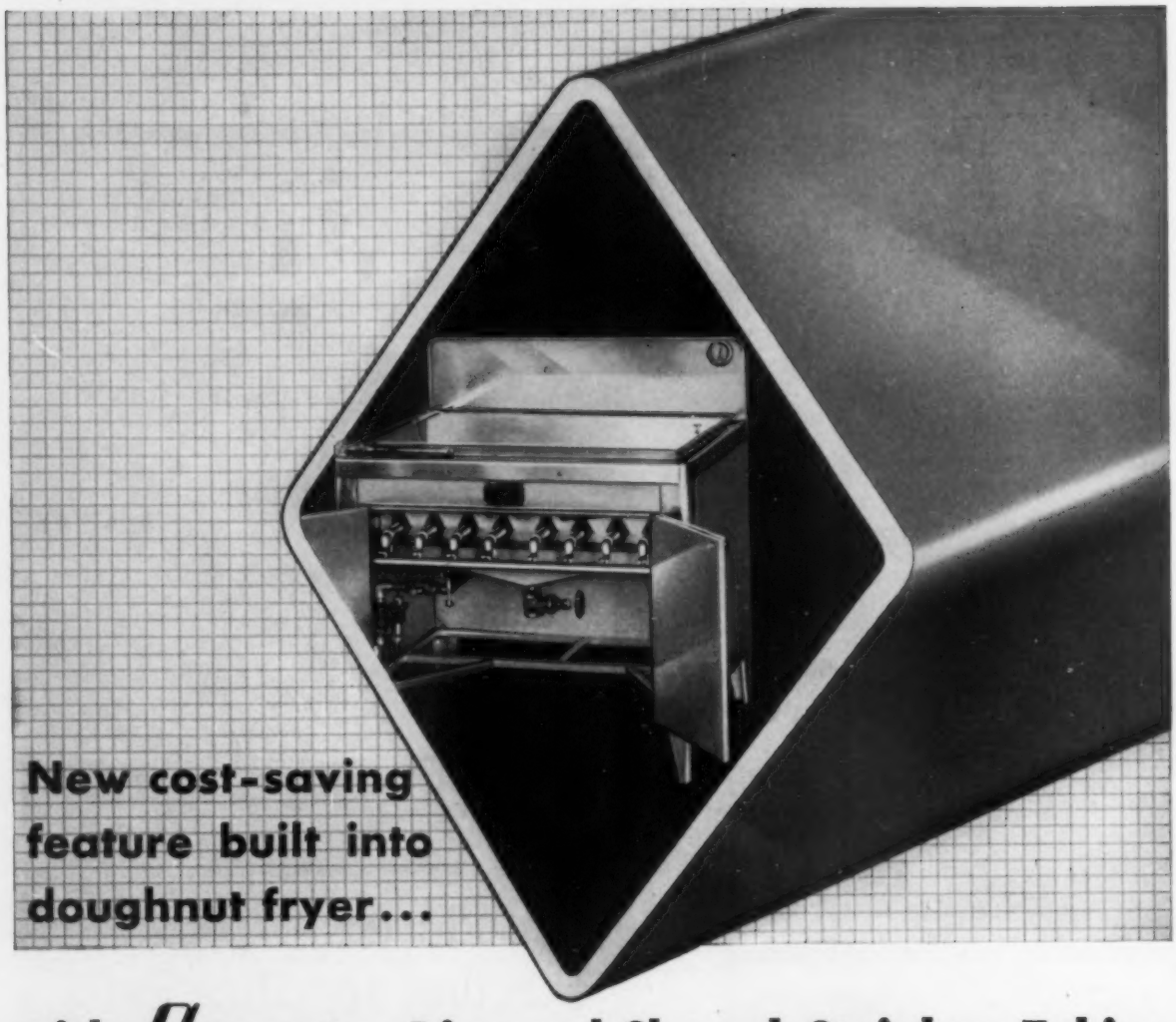

with *Carpenter* Diamond-Shaped Stainless Tubing

• A new feature in this volume doughnut fryer is the use of super sanitary heating tubes made from diamond-shaped Carpenter Stainless Tubing. The diamond shape permits faster, more economical heating because of the greater heating surface in contact with the fat. Doughnut crumbs cannot settle on the tubes, making cleaning easier and preserving the fat longer.

This is just one more example of combining the inherent advantages of stainless—high strength-weight ratio, fine appearance, corrosion and abrasion resistance and super sanitation—with the extra benefits of special shapes of Carpenter Stainless Tubing. Why not investigate the possibilities of designing and building the advantages of Carpenter Stainless Tubing shapes into your products. Call your nearest Carpenter Distributor or Branch Office for consultation and information.

MEMBER

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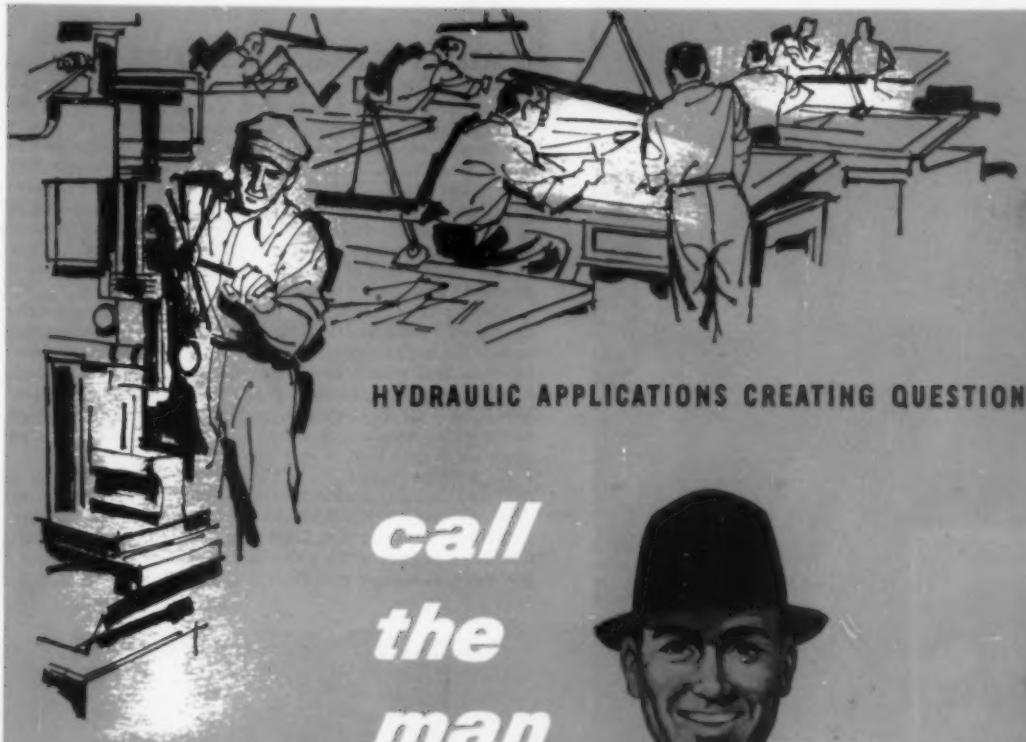
more than corrosion resistance

Stainless Tubing & Pipe



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call the man from Webster

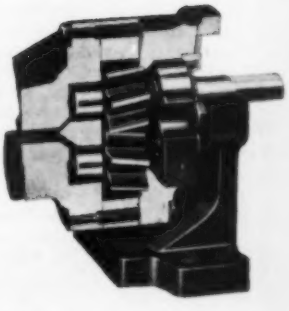
Evaluating hydraulic systems? Balancing pressures and flows against costs? Then, the man from Webster can help you. Today, when you are caught between price and performance, his technical help slanted in a fresh direction, can be the push that gets you into the clear. Call the man from Webster whenever you require hydraulic pump help for lubricating, oil circulating, filtering, transfer or quiet hydraulic power applications. He's a good man to have on your design team.

OIL HYDRAULICS DIVISION

WEBSTER ELECTRIC
MELROSE 3-3611
RACINE · WIS

OVER 100 MODELS

Capacities: *1/5 to 30 GPM*
Pressures: *Up to 1500 PSI*
Speeds: *Up to 3600 RPM*
Drives: *Direct or Geared*
Torques: *Up to 60 in. lbs./100 PSI*
Available with or without built-in relief valves



FRANKLIN ADV. H101

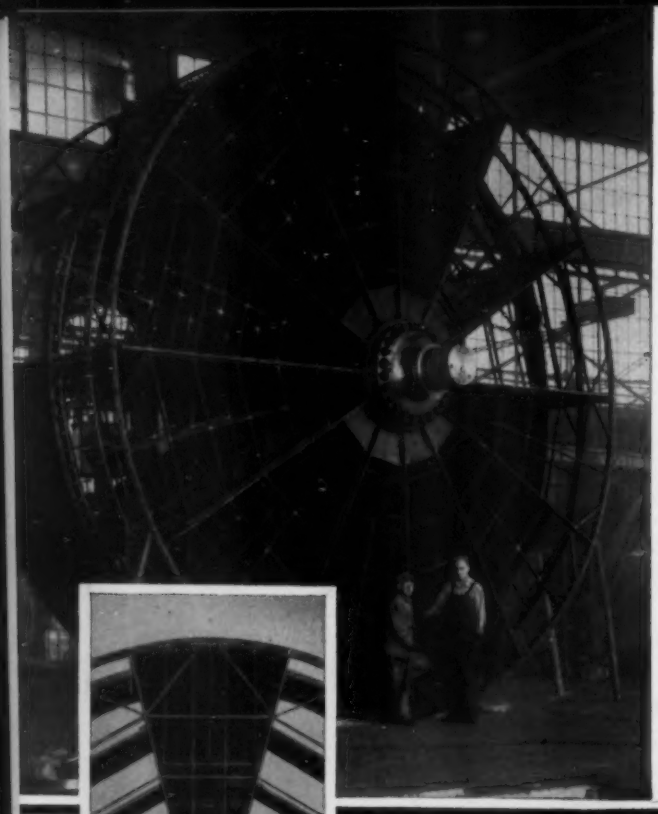
☐ *Have THE MAN FROM WEBSTER contact us—*

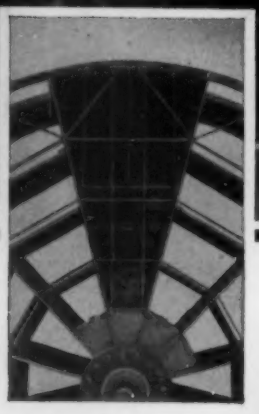
- Please send the following -

☐ *Complete hydraulic catalog of pumps and valves*

☐ *New information or data as published*

Name _____
Title _____
Company _____
Street _____
City _____ State _____



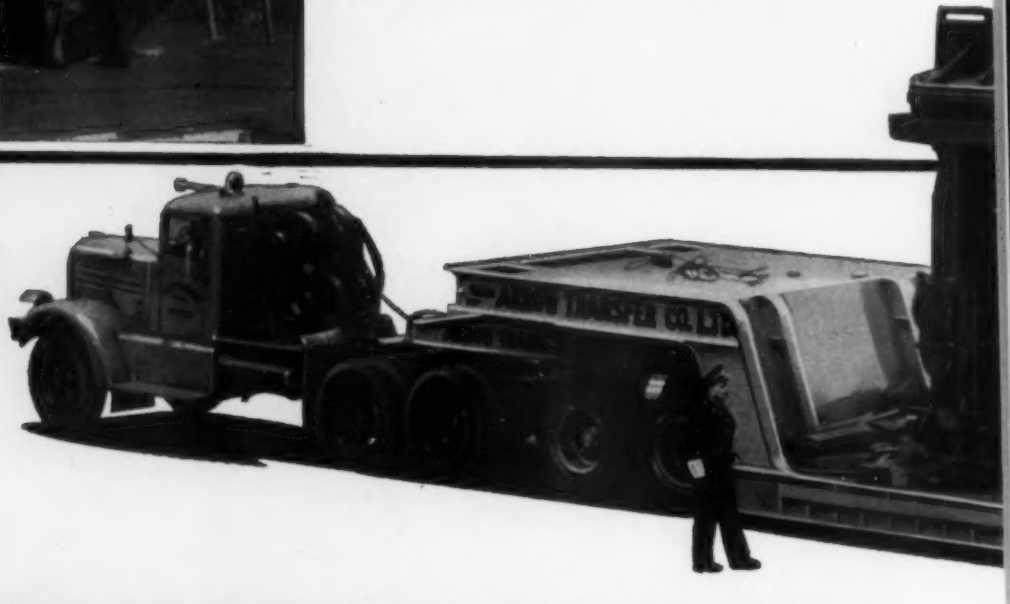


INCREASES CORROSION RESISTANCE. The huge rotor illustrated here is the main structural component of a Ljungstrom Horizontal Air Preheater. Three of these units, designed to serve a 1,900,000 pounds-per-hour-capacity boiler, are among the largest ever manufactured by The Air Preheater Corporation, New York. Each complete preheater weighs 270 tons. The rotor itself—25'2" in diameter and 10'10½" deep—when fully loaded with the heating element, weighs about 390,000 lbs.

Because sulfur in the gases combines with moisture—sulfuric acid is formed when the temperature drops below the dew point at the "cold" end of the rotor—corrosive action can be highly severe in this area. Corrosion means maintenance.

Aiming at a reduction in maintenance, the manufacturer cooperated with the U. S. Bureau of Mines in exhaustive tests to determine the corrosion resistance of various materials under sulfuric acid attack in air preheaters. These tests, made over a 5½-year period, showed that the corrosion rate of low-alloy USS COR-TEN Steel was *lower* than all but one of the *high* alloy steels tested, was less than one-half that of carbon steel and less than one-fourth that of cast iron.

As a consequence, USS COR-TEN Steel is specified for the cold end heating elements and containing baskets on all conventional boiler applications. Where unusually severe corrosion is anticipated, USS COR-TEN Steel is also specified in all or part of the rotor including diaphragm plates, bar stock, rim angle and filler plates.



INCREASES DURABILITY, REDUCES COST. Tote boxes have to take quite a beating. Used for handling, storing and shipping automotive and other parts, they must be able to withstand plenty of rough treatment.

That's why the "Hamlintainer" shown here—a *collapsible* tote box that sets up and folds flat in less than 20 seconds—is now built entirely of USS COR-TEN Steel. COR-TEN Steel's greater strength, 50% higher than carbon steel, makes it possible to build the "Hamlintainer" up to 100 lbs. lighter than carbon steel units, yet so strong and rigid that it will withstand long and rugged service and is not susceptible to bending and distortion. The fact that the COR-TEN Steel ends and sides have the stamina needed to permanently maintain their shape is of utmost importance. It means that throughout its long life the box will always be easy to set up, fold and stack flat.

As compared to the metal construction used in an earlier design, USS COR-TEN Steel makes the "Hamlintainer" not only stronger, more rigid and more durable but also less costly to produce, according to the manufacturer, Hamlin Metal Products Co., Akron, Ohio.

UNITED STATES STEEL
USS
HIGH STRENGTH STEELS
1933 1957
24 YEARS OF PERFORMANCE

High-strength USS COR-TEN Steel pays off in equipment like this

What does your product need to make it better? Greater durability? Bigger capacity? Cheaper maintenance? Lower operating cost?

Do you want to make it stronger, lighter in weight, more corrosion resistant, better able to withstand abrasion, impact and fatigue?

You can obtain any or all of these important money-saving benefits—at little or no increase in cost—by the proper use of high-strength low-alloy USS COR-TEN Steel.

USS COR-TEN Steel is distinguished by its superior resistance to atmospheric corrosion—4 to 6 times that of carbon steel, 2 to 3 times that of copper steel.

In thickness of ½" and under, COR-TEN Steel has a minimum yield point of 50,000 psi and a minimum tensile strength of 70,000 psi. In resistance to abrasion, shock and impact, it is superior to structural carbon steel. Its fatigue resistance is 60% greater.

Thus, when used to directly replace carbon steel, USS COR-TEN Steel will materially increase the strength and durability of vital parts *without* increasing their weight. Or it can be used in thinner sections (1) to reduce weight without sacrificing strength or (2) to increase the capacity of equipment without increasing gross weight or the power required to move it.

You will find our 174-page "Design Manual for High Strength Steels" extremely useful in applying USS COR-TEN or our other High Strength Steels, USS MAN-TEN and USS TRI-TEN "E" to your product. For free copy, simply write on your company letterhead to United States Steel, Room 2801, 525 William Penn Place, Pittsburgh 30, Pa.

INCREASES STRENGTH, SAVES WEIGHT. Shown here hauling a 117-ton transformer, this 150-ton-capacity trailer—built by Columbia Trailer Company, Vancouver, B. C., for the Arrow Transfer Company of that city—is the largest trailer ever built in Canada.

This 80-ft.-long trailer is constructed almost entirely of USS COR-TEN Steel. It is about 25% lighter than if it had been built of structural carbon steel. Specifically designed for handling transformers of giant size, it has a depressed center deck which makes loading and unloading easier and keeps center of gravity low to prevent danger of upset.

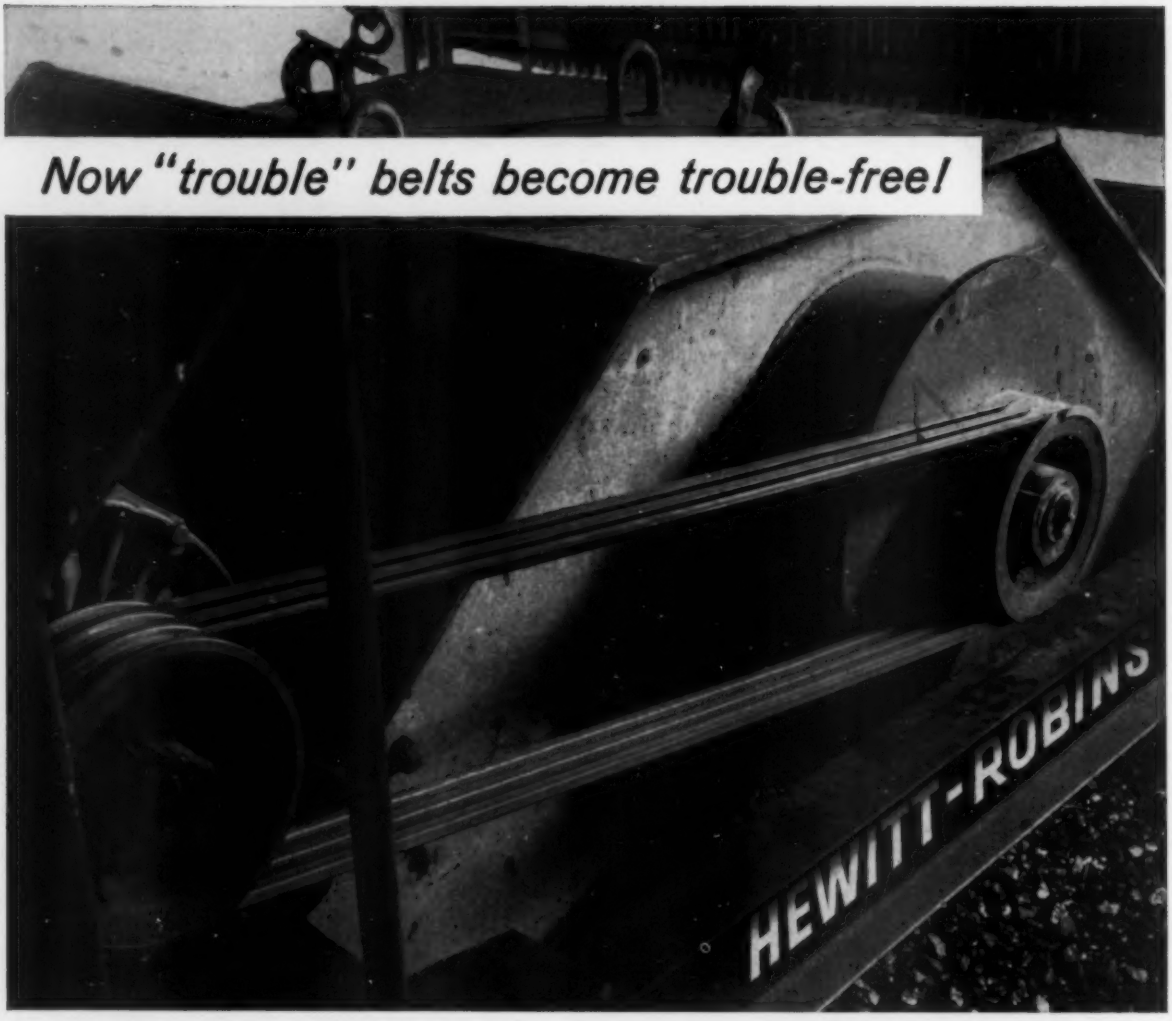
Says the manufacturer: "We have found that when a trailer is made from structural carbon steel there is a greater possibility that it can be permanently damaged from overloading than in the case of a similar unit made from high strength steels. That's why, in designing trailers of this type, we always use USS COR-TEN Steel. This construction gives us the high strength needed, plus excellent corrosion resistance and freedom from excess weight—all very important in equipment like this."

UNITED STATES STEEL CORPORATION, PITTSBURGH • AMERICAN STEEL & WIRE DIVISION, CLEVELAND • COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
NATIONAL TUBE DIVISION, PITTSBURGH • TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA. • UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS HIGH STRENGTH STEELS

USS MAN-TEN · USS COR-TEN · USS TRI-TEN

UNITED STATES STEEL



Now "trouble" belts become trouble-free!

INDIANAPOLIS POWER & LIGHT COMPANY REPORTS:

Premium V-belts reinforced with DACRON last 52 times longer than ordinary V-belts on coal unloader

REG. U. S. PAT. OFF.

The Hewitt-Robins Car Shakeout in the receiving yards of the Indianapolis Power & Light Company needed new V-belts about every three weeks before its drive was switched to V-belts reinforced with "Dacron"*. In five years' operation only one belt change has been necessary—after three years' use. Despite the rugged operating conditions involved in unloading up to 30 hopper-car loads of coal a day, these belts made with Du Pont "Dacron" lasted 52 times longer than belts reinforced with conventional fiber.

The machine that uses V-belts reinforced with "Dacron" gets up to 40% more horsepower from its belt drives than is possible with other reinforcing fibers. The ability of these belts to withstand greater shock loads coupled with their longer flex life results in remarkable durability. They stretch less and are more stable than other belts . . . require far less maintenance. And design men find they can use fewer and smaller belts and sheaves, to meet today's demand for more compact, more economical belt drives.

For the next drive you design or install, consider the advantages of premium V-belts made with "Dacron". They combine the unique properties of "Dacron" polyester fiber made by Du Pont and the highest skills of leading manufacturers who make the belts. E. I. du Pont de Nemours & Co. (Inc.), Textile Fibers Department, Wilmington 98, Delaware.

**"Dacron" is Du Pont's registered trademark for its polyester fiber.*

DU PONT

REG. U. S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*

V-BELTS OF "DACRON" transmit more horsepower . . . stand greater shock loads . . . give longer flex life . . . give greater opportunities for machine-design improvement.

ACTUATION PROBLEM too tough for ordinary devices?

SAGINAW CAN HELP YOU SOLVE IT!

Saginaw b/b Screws guaranteed 90% efficient —offer 6 major advantages for designers

Available in custom machined and commercial rolled thread types—have been built from 1½ inches to 39½ feet long—⅜ to 10 inches diameter.

Nut *glides* on steel balls. Like stripes on a barber pole, the balls travel toward end of nut through spiral "tunnel" formed by concave threads in both screw and mating nut.

At end of trip, one or more tubular guides lead balls diagonally back across outside of nut to starting point, forming closed circuit through which balls recirculate.

1 VITAL POWER SAVINGS. With guaranteed efficiency of 90%, Saginaw b/b Screws are up to 5 times as efficient as Acme screws, require only ⅓ as much torque. This permits much smaller motors with far less drain on the electrical system. Circuitry is greatly simplified.

2 SPACE/WEIGHT REDUCTION. Saginaw b/b Screws permit use of smaller motors and gear boxes; eliminate pumps, accumulators and piping required by hydraulics. In addition, Saginaw b/b Screws themselves are smaller and lighter. Units have been engineered from 1½ in. to 39½ ft. in length.

3 PRECISE POSITIONING. Machine-ground Saginaw b/b Screws offer a great advantage over hydraulics or pneumatics because a component can be positioned at a predetermined point with precision. Tolerances on position are held within .0006 in./ft. of travel.

4 TEMPERATURE TOLERANCE. Normal operating range is from −75° to +275° F., but assemblies have been designed in selected materials which function efficiently as high as +900° F. These units are practical where hydraulic fluids have lost efficiency or reached their flash point.

5 LUBRICATION LATITUDE. Even if lubrication fails or cannot originally be provided because of extreme temperatures or other problems, Saginaw b/b Screws will still operate with remarkable efficiency. Saginaw units have been designed, built and qualified for operation without any lubrication.

6 FAIL-SAFE PERFORMANCE. Far less vulnerable than hydraulics. In addition, Saginaw offers three significant advantages over other makes: (1) Gothic arch grooves eliminate dirt sensitivity, increase ball life; (2) yoke deflectors and (3) multiple circuits provide added assurance against operating failure.

YOUR FREE COPY OF THIS NEW b/b SCREW AND SPLINE "PROBLEM SOLVER" SHOWS HOW

36 pages crammed with time-, work-, and money-saving facts: Principles • Types • Basic Operations • Coupling Methods • Efficiency • Advantages • Selection Factors • Design Data • Sample Problems

SAGINAW b/b SPLINE

● Averages 40 times lower coefficient of friction than ordinary sliding splines!

Utilizing the same basic *gliding ball* principle, Saginaw has developed the *Saginaw b/b Spline* which radically increases the efficiency of transmitting or restraining high torque loads.

It can be fitted with integral gears, clutch dogs, bearing and sprocket seats, etc. Units have been built from 3 inches to 10 feet long—⅜ to 6 inches in diameter.

SEND TODAY FOR THIS FREE 1957 ENGINEERING DATA BOOK...

or see our section in Sweet's Product Design File

Saginaw ball bearing Screws and Splines

SAGINAW STEERING GEAR DIVISION OF GENERAL MOTORS

WORLD'S LARGEST PRODUCER OF BALL BEARING SCREWS AND SPLINES

Saginaw Steering Gear Division
General Motors Corporation
b/b Screw and Spline Operation
Dept. 7J, Saginaw, Michigan

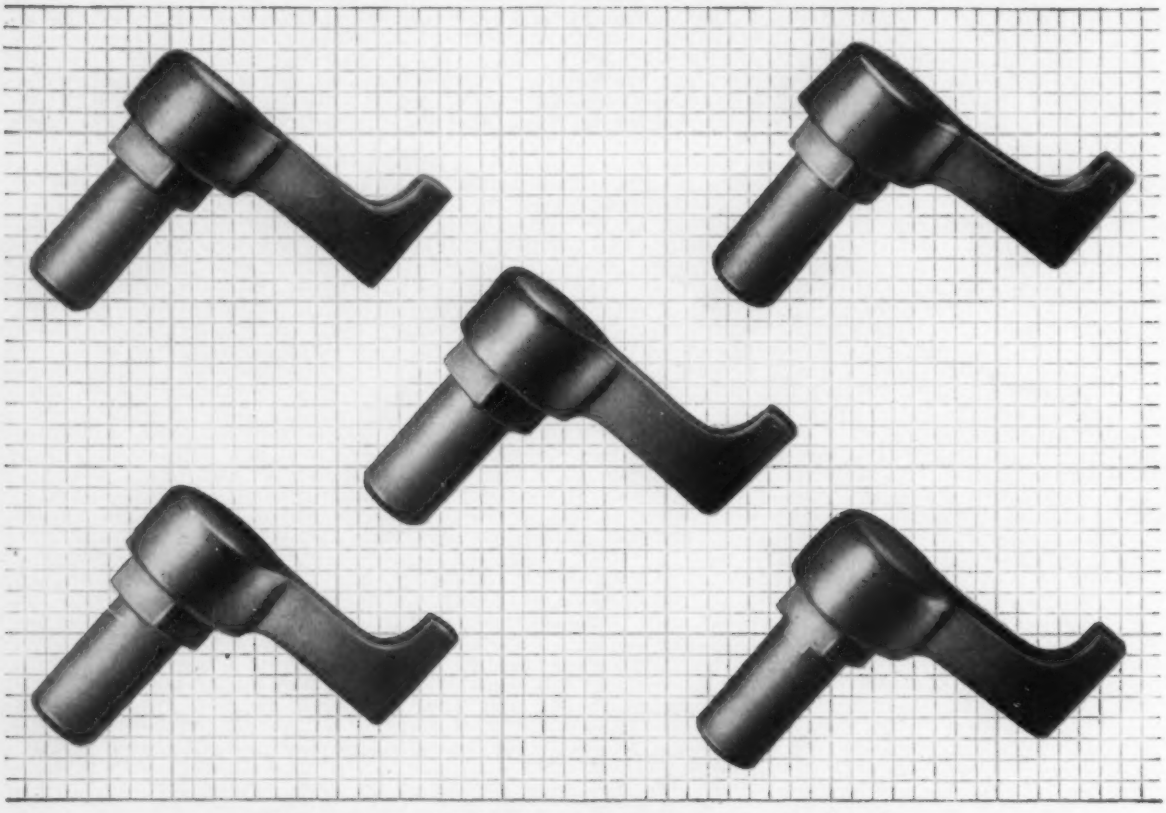
Please send new engineering data book on Saginaw b/b Screws and Splines to:

NAME_____

COMPANY_____ TITLE_____

ADDRESS_____

CITY_____ ZONE_____ STATE_____



Cam Segment—weighs less than an ounce, measures less than ½ inch.

Investment-Casting improves part ... eliminates hours of machining

HAYNES' investment-casting process made it possible to mass-produce a small intricately-shaped part in a hard, abrasion-resistant alloy. The part, a cam segment, is less than one-half inch long, and weighs only a fraction of an ounce. It is cast to size. Only one simple threading operation is required to prepare it for operation.

The cam segment is used in a control instrument and rides against a valve shaft under pressures up to 35 lb. per sq. inch. At one time it was cast from a relatively soft metal and machined to final dimensions. The machining time for each cam was several hours—an expensive operation. The performance of the part was unsatisfactory because the metal used was selected for ease of machining—and could not stand up under the abrasive conditions.

The investment-cast segments are now made of type 410 stainless steel. They have been used for over one million operations and still show no signs of wear.

The freedom to select alloys for performance, regardless of how difficult they may be to machine, is one of the big advantages of HAYNES' investment-casting method. Intricate shapes in hard metals can be cast close to size, eliminating many machining operations. For full details on the process, write to our general sales office in Kokomo, Indiana, or any of the district sales offices listed below.

HAYNES TRADE-MARK ALLOYS

HAYNES STELLITE COMPANY

A Division of Union Carbide and Carbon Corporation

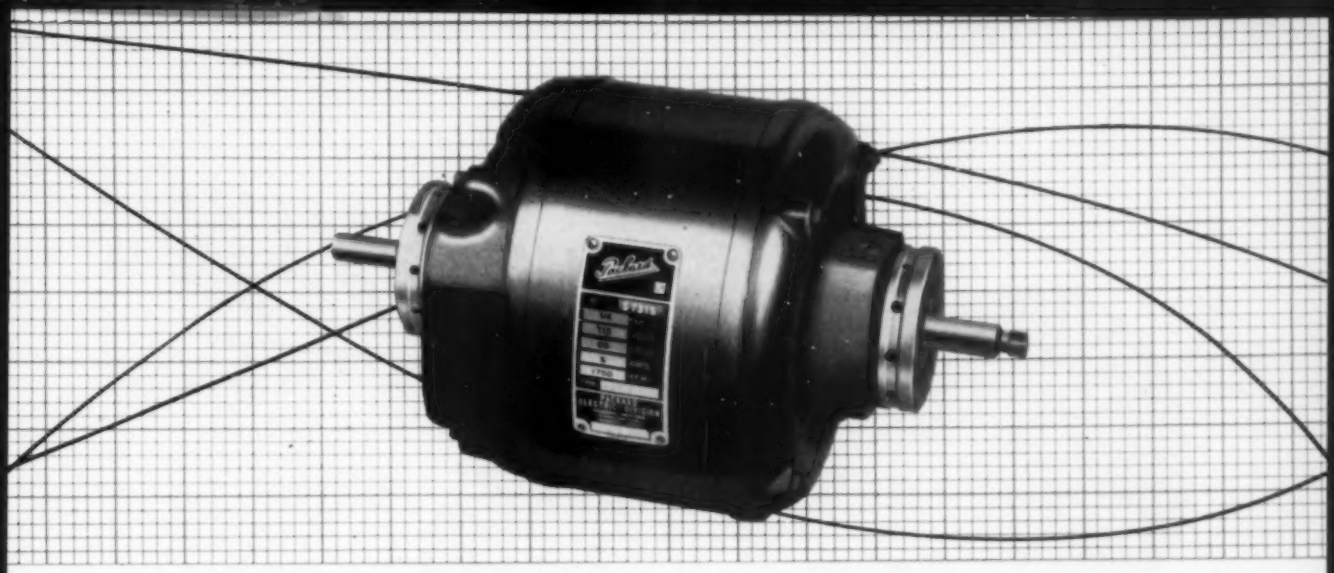
UCC

General Offices and Works, Kokomo, Indiana

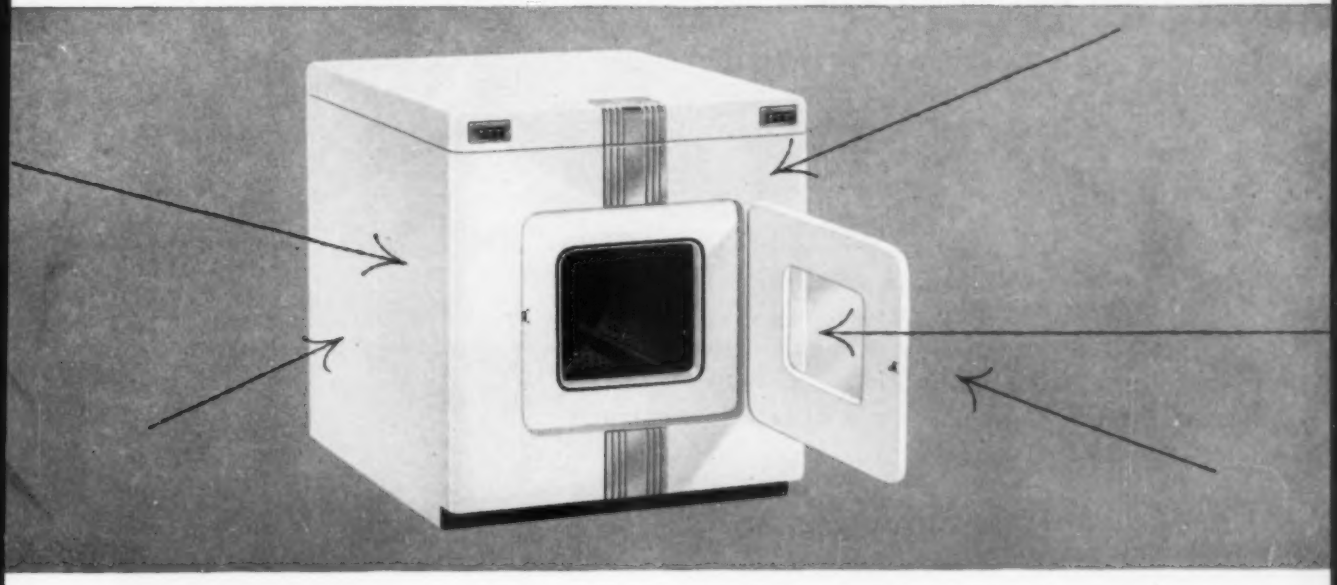
Sales Offices

Chicago • Cleveland • Detroit • Houston • Los Angeles • New York • San Francisco • Tulsa

"Haynes" is a registered trade-mark of Union Carbide and Carbon Corporation.



PACKARD ELECTRIC / *Because this motor was custom-tailored*



FHP MOTORS / *this dryer is built better at lower cost!*

Packard Electric direct factory sales and engineering contact consistently pays off. In this case it did for a dryer manufacturer.

The payoff came in a motor custom-tailored to dryer requirements . . . not merely a conveniently adapted motor. This means that the motor has the exact characteristics—speed, power and torque—for its job. Because of that, it could be advantageously priced.

What's more, it can be supplied with power supply cord already attached—complete and ready for installation. This results in still more savings.

Packard Electric research and engineering teams are busy today developing new motors. And as always, our objective is to enable customers to produce better, lower priced products in the future.

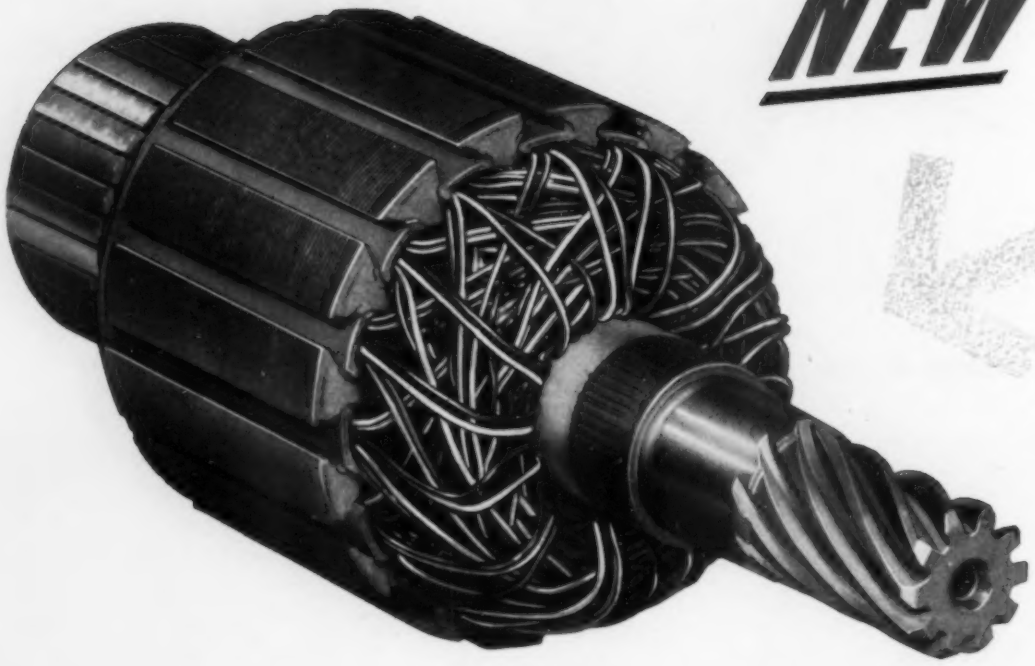
Packard Electric

Warren, Ohio

GM GENERAL MOTORS

Division of General Motors

NEW



THESE 4 FEATURES MAKE NEW R & M ARMATURES OUTSTANDING

■

All coils are wound simultaneously. Coils are exactly identical, assuring identical electrical and physical characteristics. Conventional methods produce windings with individual coils having varying amounts of wire and consequent non-symmetry.

■

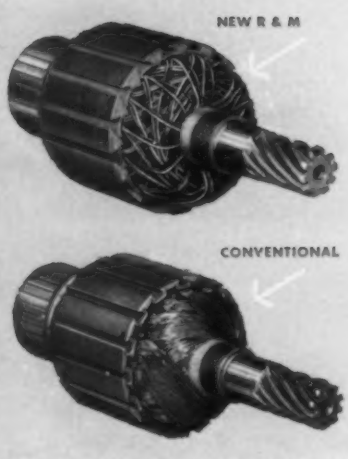
Armature coils are uniformly positioned and anchored securely. Interlocked winding pattern resists conductor and coil end movement. This unique construction minimizes abrasion of wire insulation, a common cause of high speed armature failure.

■

Maximum coil end exposure resulting from distinctive winding pattern permits maximum heat dissipation. Lower temperatures prolong armature life.

■

More uniform electrical characteristics reduce arcing at brushes, improving commutation and prolonging brush life.



ROBBINS & MYERS, INC.

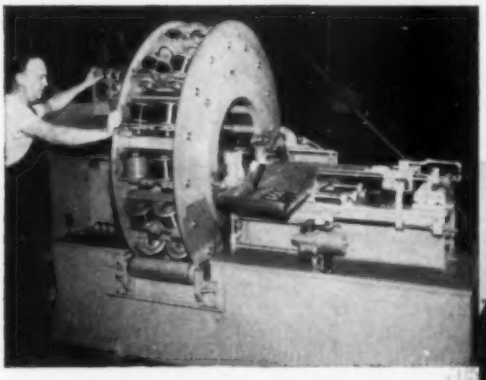
SPRINGFIELD, OHIO | BRANTFORD, ONTARIO

R & M PRECISION MACHINE-WOUND ARMATURES

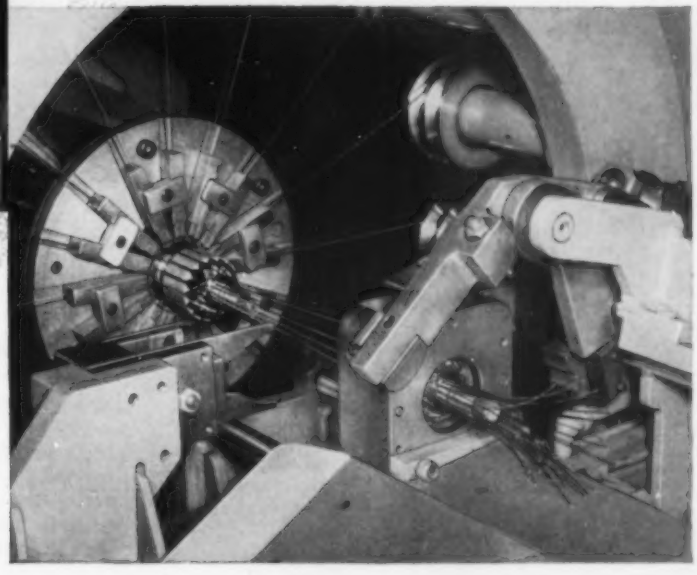
can improve your product's performance!

A new basic development in armature winding technique, perfected by Robbins & Myers, now produces armatures for Universal or Series Motors which are superior to those heretofore available for original equipment manufacturing. The new R & M armature winding machine winds all coils simultaneously . . . uniformly positions them . . . and the coils are physically and electrically identical! Weaknesses inherent in armatures wound by conventional methods are eliminated. The new R & M machine produces armatures of finer, more uniform construction which will give longer, more dependable service!

Contact a Robbins & Myers representative for additional details on R & M universal motors and series motor parts or write for Bulletins 444-PE and 455-PE.



AUTOMATION AT R & M SPEEDS ARMATURE WINDING AND IMPROVES ELECTRICAL AND PHYSICAL QUALITIES OF PRODUCT.



R&M

MICRO SWITCH Precision

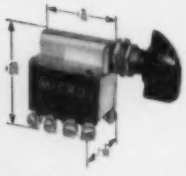
...FIRST IN PRECISION SWITCHING

If reliability, long life, ruggedness, compactness, sensitivity and accurate repeat point of operation are vital to you, then

Look to MICRO SWITCH for a solution of your Precision Switch problems

Here is a partial picture of some of the thousands of switch combinations available—news of a new MICRO SWITCH development—how and for what and why one manufacturer is using MICRO SWITCH Precision Switches—and a report on what MICRO SWITCH field application engineering can mean to alert design engineers

This MICRO SWITCH 3-Position Rotary Actuated Switch is compact and rugged



Ideal for airborne and industrial use, this switch is a four-pole double-throw switch with 12 terminals (catalog listing 4TR1). An eight-pole with 24 terminals is also available (catalog listing 8TR1) . . . Eliminates use of relays. Tested for impact, shock, acceleration and vibration. Careful inspection assures long life operation. Positively detented positions eliminate accidental operation. The solid silver contacts and silver-plated copper moving contact carrier provide maximum conductivity, minimum temperature rise.

(*For more details ask for Data Sheet No. 112*)

CHARACTERISTICS

Operating Torque (4TR1) . . 9 in. lbs. max.
Pretravel . . . . . 10° each direction
Operating Torque (8TR1) . . 4 in. lbs. min. to 6 in. lbs. max.

ELECTRICAL RATING 4TR1 & 8TR1

Continuous	Resistive Load		Lamp Load		Inductive Load	
	30 v dc	115 v ac	30 v dc	115 v ac	30 v dc	115 v ac
20	20	20	5	4	12	15

This Compact Limit Switch Is Widely Used by Industry

This is a double-pole two-circuit switch, completely sealed. Cover screws are held captive in cover when it is removed. The ½ n.p.t. internally tapped opening is in the bottom of the enclosure . . . Actuator can be positively locked in any position through 360° and can be operated in either direction. Actuator head is removable in field, can be rotated to any of four positions. This switch can be mounted either front or back side, .192-inch diameter holes extend through the enclosure, tapped from the back to a depth of 9/16-inch with ¼-20 nc thread. Mounting holes accept No. 10 screws. No. 8 terminal screws accommodate No. 14 stranded wire. Can be used single-pole double-throw.

(*Ask for Catalog 101*)

CHARACTERISTICS

Operating force—3 lbs. max. Pretravel—20° max.
Full overtravel force—6 lbs. max. Diff. travel—12° max.
Release force—½ lb. min. Overtravel—30° min.

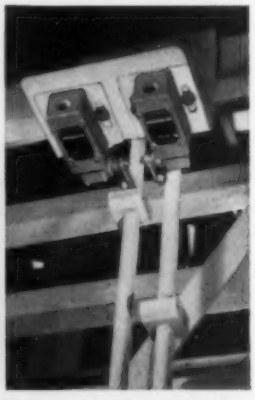
Rated: 10 amps. 120, 240, 480 v ac; ½ H.P. 120 v ac; 1 H.P. 240 v ac; .8 amp. 115 v dc; .4 amp. 230 v dc; 1 amp. 550 v dc. Pilot duty rating 600 v ac. max.

15 MICRO SWITCH Precision Limit Switches Assure ABSOLUTE DEPENDABILITY in Particle Board Loader and Unloader Unit*

Operates 20,000 cycles per day on a 24-hour basis

•

Prevents shut-down time at estimated cost of $50.00 to $100.00 per minute



Three of the many MICRO SWITCH Type "ML" 2-circuit switches index the cage stops of the upward and downward travel of the racks of the particle board loader and unloader unit.

Operating 20,000 cycles a day, these rugged MICRO SWITCH "ML" Limit Switches with their long life, accurate repeatability of point of operation, excellent seal, convenient mounting and one-way actuation features, provide dependability for the continuous high speed production of particle board.

Serving as indicators and timers in various automatic operations, these two-circuit switches control the up and down motion of the unit which loads and unloads the particle board to and from the hot plate press.

The manufacturer* of these custom-built units has standardized on MICRO SWITCH Precision Switches because of their longer life, accurate and dependable operation and excellent environmental seal. As many as 100 switches are used on some of these custom-built units.

(*Ask for Catalog No. 83 "Industrial Enclosed Switches"*)

*Washington Iron Works, Seattle, Washington

Switches have uses unlimited

NEW!

A Subminiature Screwdriver Operated Switch— Saves Wiring and Panel Space

Designed to be used where there is limited access and where accidental operation must be prevented. Switch is operated by a 90° turn of a screwdriver and the slotted head gives visual indication of its position. The switch can be ordered with a number of variations of the subminiature basic switch. Contact arrangement is single-pole double-throw (maintained position).

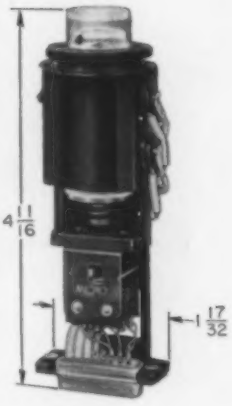
(To learn full details of this new switch, send for Data Sheet No. 115)

ELECTRICAL RATING

Listed by Underwriters' Laboratories at 5 amps. 125 or 250 v ac. The 30 v dc is: inductive—3 amps. at sea level, 2.5 amps. at 50,000 ft., resistive—4 amps. at both sea level and 50,000 ft. Maximum inrush capacity—20 amps. ac and 24 amps. at 30 v dc.

MICRO SWITCH 3-Light Pushbutton Switch Reduces Panel Space 50%

This compact, double-throw double-pole switch with its prewired plug will light in three different colors. It was developed expressly for use in complex console panels. Because push button and switch are combined in one unit, it reduces panel space by 50%. The compact stem carries three separate lamps. The switch incorporates a special connector plug which permits quick and easy installation and replacement—no complicated wiring required. Designed for use where high reliability is a requirement; two SPDT precision subminiature basic switches with fine silver or gold contacts and special treated snap-acting springs are the switching elements. All materials are corrosion resistant.

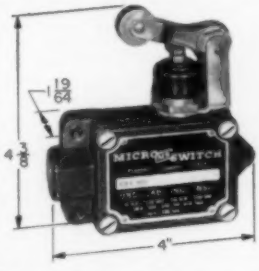


(Data Sheet No. 110 will give you more details. Send for it!)

ELECTRICAL RATINGS

Rated for .1 amp. inductive at 28 or 48 v dc and 1 amp. inductive at 115 v ac.

For Tough Service in Industrial Applications— The "BAF1" High Capacity Series



Especially designed for rough, general service in industrial applications, these MICRO SWITCH Precision Switches are protected from the effects of dirt, dust and occasional liquid splash by an elastomer boot on the plunger and an O-ring gasket under the cover plate . . . This series is really rugged, the three mounting holes in the heavy mounting flange accommodate ¼ in. bolts. These switches have a capacity to make and break steady state currents of 20 amperes and will handle inrush currents as high as 75 amperes. If your service requirements are rugged, this rugged switch will handle them.

(You can learn all about this series, if you send for Catalog No. 83)

CHARACTERISTICS

Operating force	2 lbs.
Release force	1/2 lb. min.
Pretravel	7/32 in. max.
Overtravel	1/4 in. min.
Differential Travel	.015 in. max.

Service Pays Off Again; for Orin McIntyre

"We don't sell switches, we *give* service. Give them the right switch for the job and the switches sell themselves."

That's the sales approach of Orin Mac McIntyre, MICRO SWITCH salesman. And Mac's approach recently paid off.

Mac offered his talents to a prospective customer's engineers, hoping to assist them with their switching problems.

Mac kept at it and finally found the "in." The prospect needed heavy-duty limit switches with extremely light operating force and soft-roller actuators to prevent breakage of his product. Mac checked the home office, found the perfect solution, and had two samples in the hands of the prospect—pronto.

This prospect's engineers found these switches ideal for their needs, and issued an order.

This fast and efficient service made an impression. Soon Mac was called in on another switching problem which resulted in a second order.

Through Mac's efforts, MICRO SWITCH has gained the added respect of this company.

MICRO SWITCH

A DIVISION OF MINNEAPOLIS-HONEYWELL REGULATOR COMPANY

In Canada, Leaside, Toronto 17, Ontario • **FREEPORT, ILLINOIS**

High-speed sigma welding a 5-in. thick alloy paper mill roll. Note top quality of multipass weld beads.

. . . SIGMA WELDING AND ALLOYED METALS

Because sigma welding joins modern alloys of varying types and thicknesses in fast, clean operations, it has gained recognition by manufacturers throughout industry as the most efficient welding process for a wide range of alloy fabricating jobs.

Combines Advantages

Sigma welding is an extremely versatile process—it joins metal alloys ranging in thickness from 0.035 inch to more than five inches (in multipass operations)—and attains up to four times faster wire deposition than other welding processes.

Gain the full advantages of modern sigma welding . . . Contact your local LINDE Representative for complete information, or write today for free literature.

Linde Air Products Company
A Division of Union Carbide and Carbon Corporation
30 East 42nd Street UCC New York 17, N. Y.

Offices in Other Principal Cities
In Canada: LINDE AIR PRODUCTS COMPANY
Division of Union Carbide Canada Limited, Toronto

The term "Linde" is a registered trade-mark of Union Carbide and Carbon Corporation.

Linde
Trade-Mark

VS-100

new all-electric machine tool feed drive

No pick-off gears or gear changes are necessary with the VS-100. Infinitely variable 100 to 1 speed range offers high speeds for rapid traverse as well as the slowest feed rates.

Feeds may be precisely selected and rapidly changed, even during a cut. The push button operator's station provides easy, instantaneous feed control. This remote station contains controls for start, stop, jog, reverse, and speed changing . . . ideal in pendent station mounting for maximum operator's convenience. Additional functions, such as automatic dwell and automatic feed programming are available for the operator's station.

The VS-100 operates from 220 or 440 volt, single phase, a-c. circuits. Seven sizes are available ranging from ½ thru 4 horsepower. For complete details write for bulletin D-2501. D-1540

RELIANCE ELECTRIC

AND ENGINEERING COMPANY

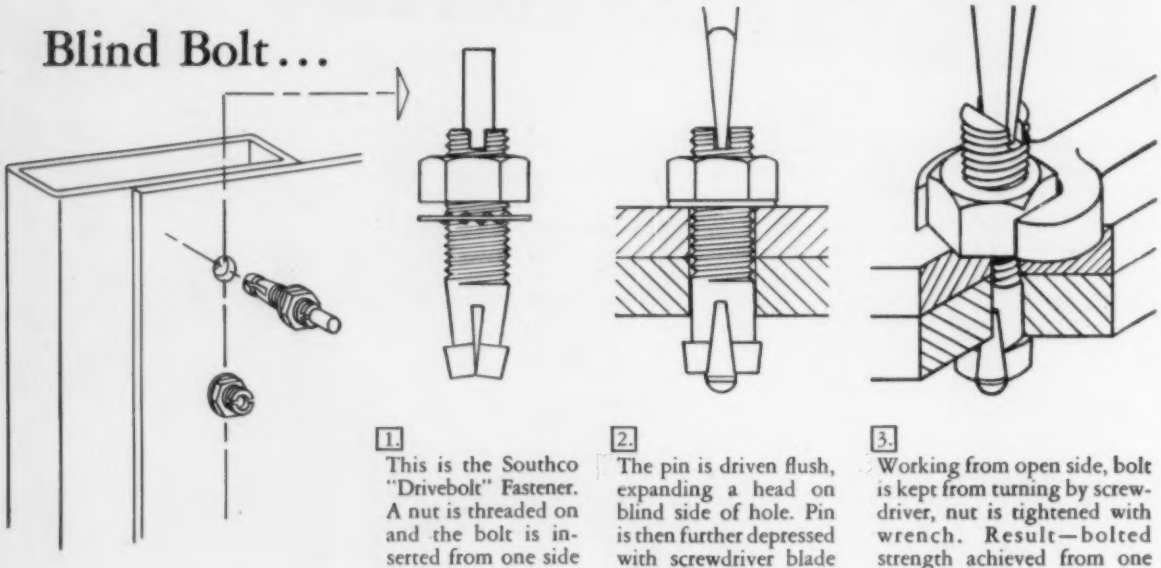
DEPT. 303A, CLEVELAND 17, OHIO • CANADIAN DIVISION: WELLAND, ONTARIO

Sales Offices and Distributors in Principal Cities

Simplified Bolting and Riveting in Blind Applications

For fastener applications accessible only from one side of the work, you can now bolt or rivet without special tools . . .

Blind Bolt . . .

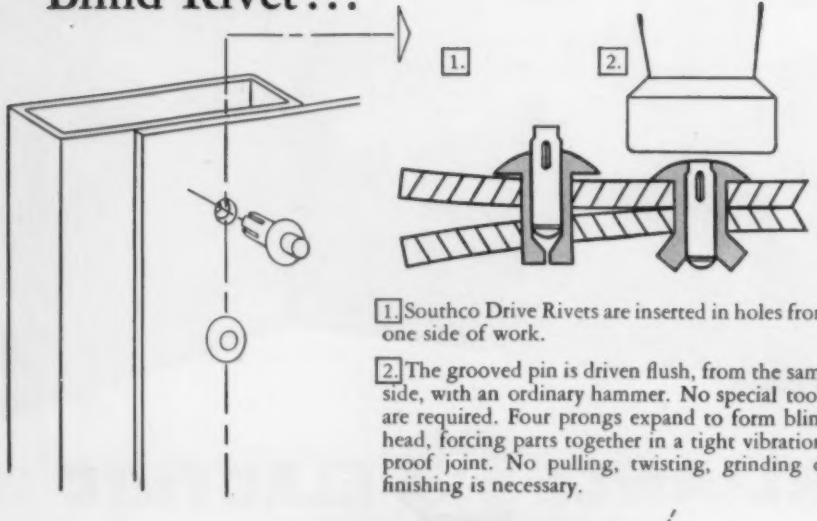


1. This is the Southco "Drivebolt" Fastener. A nut is threaded on and the bolt is inserted from one side of the work.

2. The pin is driven flush, expanding a head on blind side of hole. Pin is then further depressed with screwdriver blade to clear slot.

3. Working from open side, bolt is kept from turning by screwdriver, nut is tightened with wrench. Result—bolted strength achieved from one side of job.

Blind Rivet . . .



1. Southco Drive Rivets are inserted in holes from one side of work.

2. The grooved pin is driven flush, from the same side, with an ordinary hammer. No special tools are required. Four prongs expand to form blind head, forcing parts together in a tight vibration-proof joint. No pulling, twisting, grinding or finishing is necessary.

FREE!

Fastener Handbook

Send for your free copy of Fastener Handbook No. 7, just released. Gives complete engineering data on these and many other special fasteners. Fifty-two pages, in two colors.

Write on your letterhead to Southco Division, South Chester Corporation, 236 Industrial Highway, Lester, Pa.

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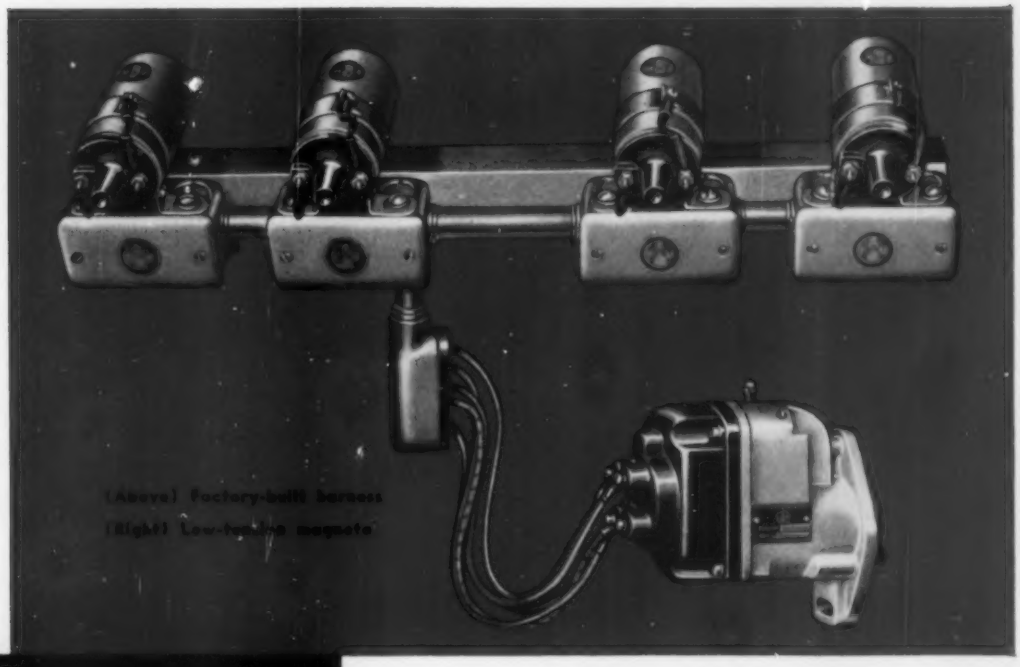
SOUTHCO FASTENERS

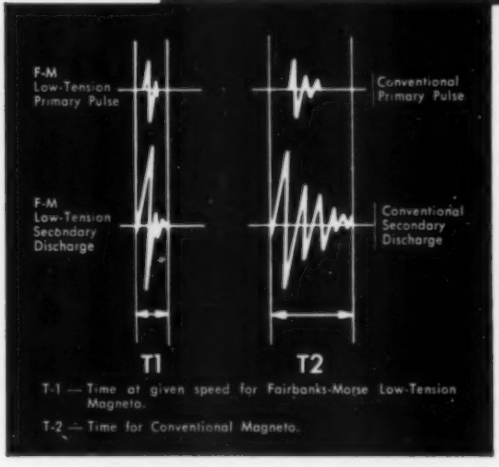
LION

New LOW-TENSION ignition systems

improved firing gives longer service on 1, 2, 4, 6, 8 - cylinder spark-ignited engines



(Above) Factory-built harness
(Right) Low-tension magneto



T-1 — Time at given speed for Fairbanks-Morse Low-Tension Magneto.

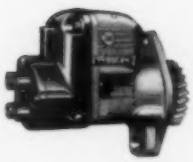
T-2 — Time for Conventional Magneto.

New model engines with their higher compression ratios, as well as thousands of engines already in the field, all show vastly improved performance with the Fairbanks-Morse low-tension ignition system. The short duration, high peak voltage spark liberates more than enough energy (heat) to ignite a full charge under all engine operating conditions.

Bearings and other magneto parts last longer because there is no problem with ozone or high corona discharges within the magneto case. In addition, a major improvement in spark plug life results from reduced electrode erosion due to the shortened voltage-time characteristic.

Fairbanks-Morse low-tension magnetos are no larger than standard units, thus simplifying installation. Complete factory-built harnesses that include transformers, junction boxes, mounting hardware, lead wires, etc. are available for nearly all popular engines up to 4000 cu in. in displacement.

MORE THAN 4,000,000 MAGNETOS IN USE



FAIRBANKS-MORSE

A name worth remembering when you want the BEST

MAGNETOS • REWIND STARTERS • WATER SYSTEMS • GENERATING SETS
PUMPS • MOTORS • SCALES • DIESEL LOCOMOTIVES AND ENGINES

Fairbanks, Morse & Co., Magneto Division
Beloit, Wisconsin

Please send Bulletin FM238A describing the Fairbanks-Morse low-tension ignition system.

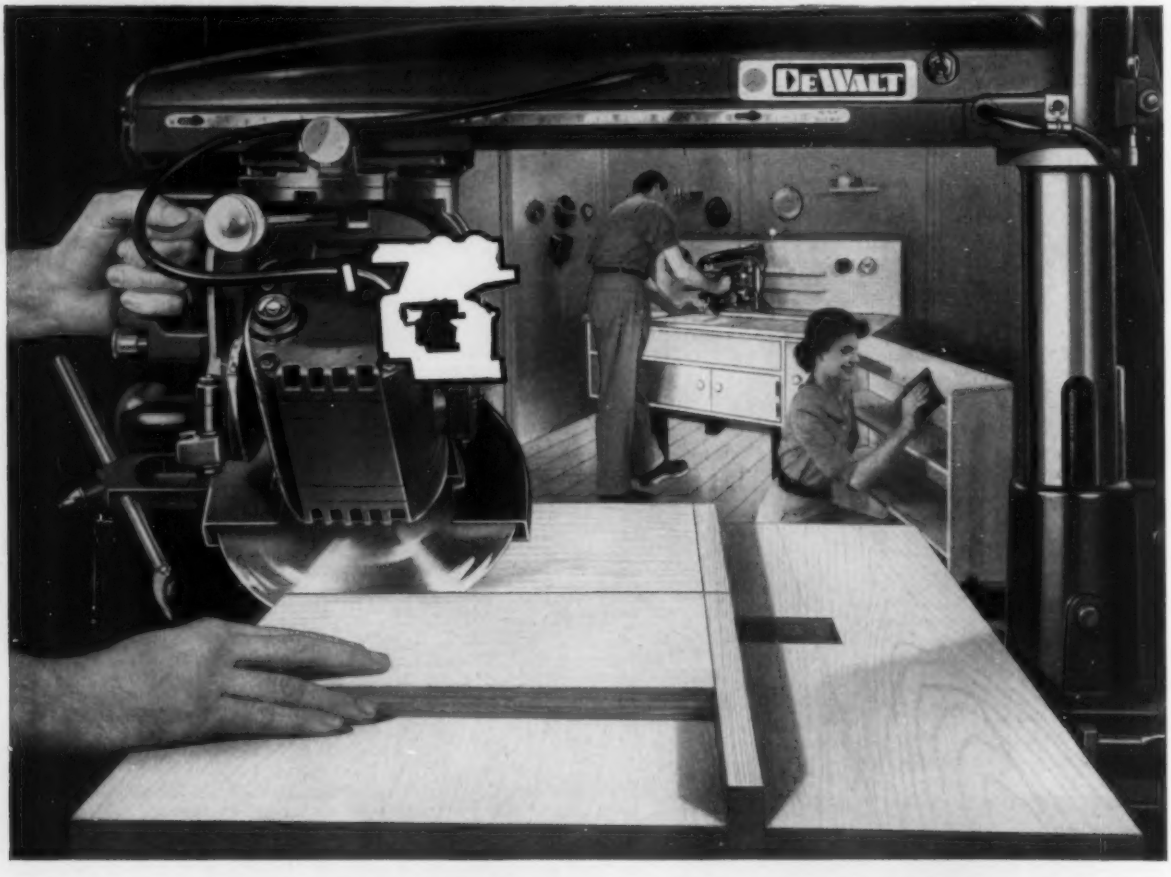
Name_____

Company_____

Address_____

City_____ State_____

Potter & Brumfield *engineering is in this picture*



Which P&B relay would you specify for

THIS HIGH STARTING TORQUE MOTOR?

MP SERIES

MS SERIES

AB SERIES

Radial Saws by DeWalt, Inc. are used in thousands of home workshops, in lumber yards, carpenter shops and industry. The electric motors that operate these saws are a heavy duty, single phase, AC, modern capacitor, voltage relay type. They have a *high starting torque* in order to quickly achieve operating speed, even when heavy line loads give lower voltage than normal. To avoid arcing and burning during initial current surge, DeWalt needed a positive, fast acting relay that would remain in contact until operating speed was reached.

Their choice? P&B MP series relays! These sturdy relays not only save arcing and burning during initial current surge, but are compact, rugged and dependable. Their versatility permits use with any capacitor type motor up to 2 horsepower. They can be furnished with an alnico magnet if whole snap action is needed.

This ready solution to DeWalt's relay problem is an example of how P&B relay engineering is daily adapting existing relay types to specific needs. P&B's unique 25 years of relay engineering experience provides an immense reservoir of skill, information and technical ability that can help solve your relay problems faster and more efficiently.

ENGINEERING DATA

SERIES: MP. Small general purpose power relay.

CONTACTS: ⅜" fine silver rated 25 amp., 115 V. AC non-inductive load, or 2 HP, 115 V. AC.

CONTACT ARRANGEMENTS: SPST NO, SPST NC, SPDT.

VOLTAGE RANGE: DC: Up to 220 V. AC: Up to 230 V.

COIL RESISTANCE: 15,000 ohm maximum.

TEMPERATURE RANGE: DC: −55° C. to +85°C. AC:−55°C. to +55°C.

TERMINALS: Standard pierced solder lug holes will take No. 10 hook-up wire.

ENCLOSURES: Dust cover, 2-59/64" L. x 2⅛" W. x 2-3/32" H. Hermetically sealed cover dimensions same as above.

DIMENSIONS: Maximum 2¼" L. x 1¼" W. x 1⅞" H.

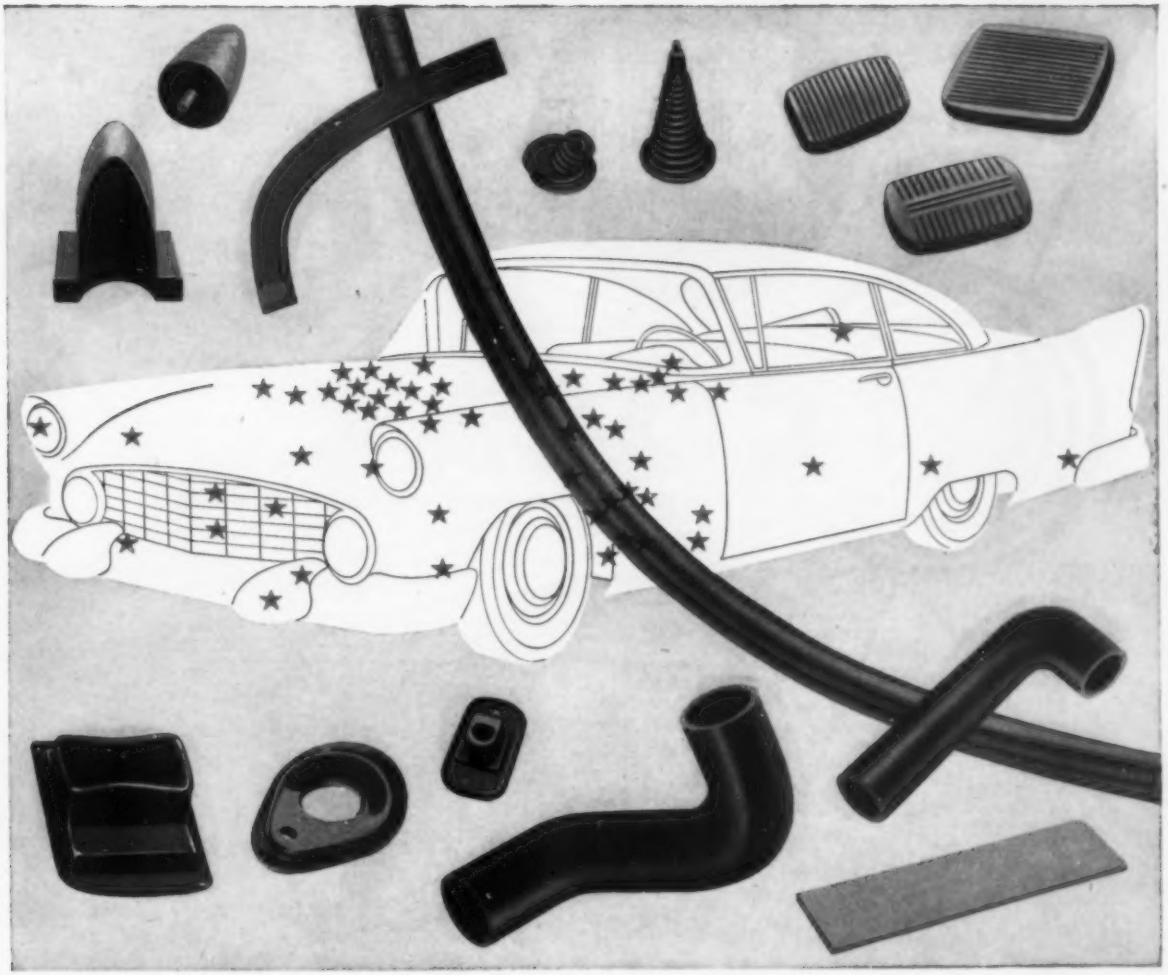
This relay will normally deliver a minimum of 300,000 operations before wear will warrant readjustment.

P&B STANDARD RELAYS ARE AVAILABLE AT YOUR LOCAL ELECTRONIC, ELECTRICAL, AND REFRIGERATOR DISTRIBUTORS

See our catalog in Sweet's Product Design File

Potter & Brumfield, inc. PRINCETON, INDIANA

Subsidiary of AMERICAN MACHINE & FOUNDRY COMPANY • Manufacturing Divisions also in Franklin, Ky. and Laconia, N. H.



★ some of the more than 100 places where ENJAY BUTYL works, silently and dependably, helping to improve the performance of today's new cars.

ENJAY BUTYL— fabulous all-weather rubber
BOOSTS PERFORMANCE IN '57 CARS

Molded into more than 100 parts, this super-durable, all-weather rubber helps provide a steadier, softer, more silent ride under even the most strenuous conditions of stress, weather change, and abrasive action. The dependability of all these parts contributes to the outstanding performance of the modern car.

Readily available in non-staining grades, Enjay Butyl rubber can be compounded into white and light-colored parts that combine beauty with top-notch performance. Low in cost, it out-performs and out-lasts all other rubbers formerly used, and may well be able to *cut costs* and *improve performance* in *your* product. For further information, and for expert technical assistance, contact the Enjay Company.

ENJAY BUTYL

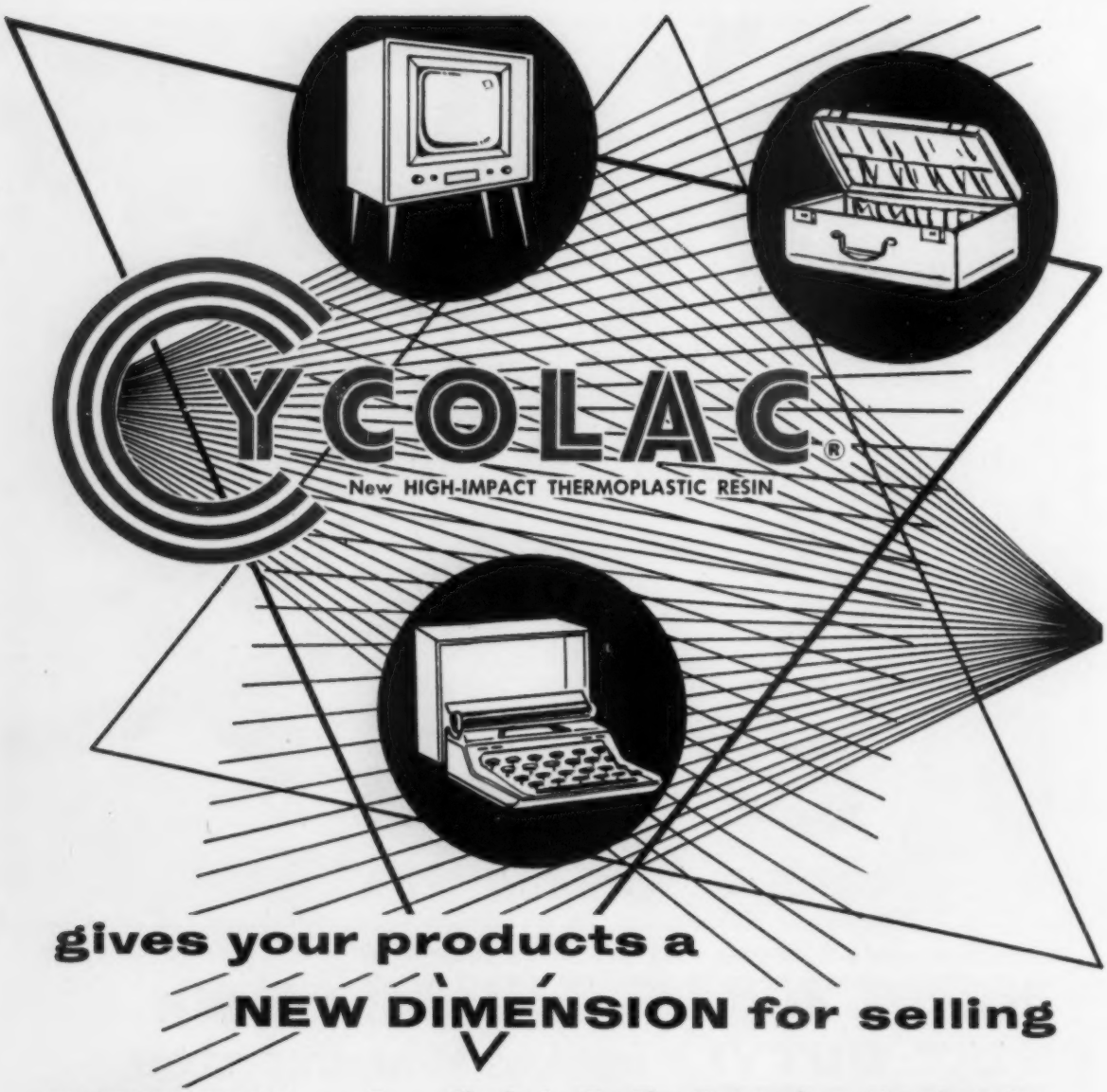
Enjay Butyl is the greatest rubber value in the world . . . the super-durable rubber with *outstanding* resistance to aging • abrasion • tear • chipping • cracking • ozone and corona • chemicals • gases • heat • cold • sunlight • moisture.

ENJAY

Pioneer in Petrochemicals

ENJAY COMPANY, INC., 15 West 51st Street, New York 19, N. Y.

Akron • Boston • Chicago • Los Angeles • New Orleans • Tulsa



gives your products a NEW DIMENSION for selling

THE PERFECT RESIN FOR THE MANUFACTURE OF ANY PRODUCT THAT DEMANDS . . .

- Chemical Resistance
- Lightweight
- Non-Corrosion
- Dimensional Stability
- High Impact Strength
- Machineability
- Economic Molds
- Low Brittle Point
- High Heat-Distortion

Check In To The Tremendous Manufacturing Possibilities Offered Thru the Use of CYCOLAC

If you are in the business of manufacturing post-formed business-machine housings, typewriter cases, containers, signs, instrument cases, luggage, etc. CYCOLAC sheet can be produced by extrusion, calendering or press-polishing. CYCOLAC sheet is tough yet lightweight; low shrinkage, is colorful, and can be embossed or grained, solvent-welded, sawed, drilled, buffed, painted, etc.

Get the facts . . .

WRITE TODAY FOR TECHNICAL LITERATURE

MARBON CHEMICAL
Division of BORG-WARNER
GARY, INDIANA

MARBON CHEMICAL . . . *Precision Resins for Precision Made Products*

build reliability into your product with OHMITE® COMPONENTS

close-control RHEOSTATS

All-ceramic and metal, close-control rheostats for unsurpassed dependability and smoothness of operation. Ten stock sizes, 25 to 1,000 watts.

wire-wound RESISTORS

A wide range of dependable, fixed, adjustable, tapped, and noninductive power wire-wound resistors. Also a wide range of precision resistors.

general-purpose RELAYS

65 Types in four stock models. Good delivery on made-to-order relays. Contact current ratings up to 25 amps, AC or DC. Wide variety of contact arrangements. Hermetically sealed or dust-protective enclosures available.

high-current TAP SWITCHES

Five compact models, up to 100 amperes, AC, up to 12 taps. All-ceramic and metal construction. Silver-to-silver contacts, with self-cleaning rotor contact.

radio-frequency CHOKES

Single layer R.F. plate chokes and power line chokes on steatite or plastic cores. Protected by a special moisture-resistant coating.

WRITE on Company Letterhead for Catalog and Engineering Manual.

Be Right with OHMITE®

RHEOSTATS • RESISTORS • RELAYS • TAP SWITCHES • TANTALUM CAPACITORS

OHMITE MANUFACTURING COMPANY • 3611 Howard Street, Skokie, Illinois

OHMITE®

AMRECON® *Relays*

HIGH QUALITY, ALL-PURPOSE RELAYS... RUGGED, DEPENDABLE FOR LONG LIFE!

65 types in four stock models

Ohmite Amrecon relays have proven their exceptional ruggedness and long life in years of service. Now, four popular stock models—DOS, DOSY, DO, and CRU, in 65 different types—are available from stock.

Models DO and DOS fill many industrial needs for a compact, lightweight relay that handles power loads usually requiring much larger, heavier units. They are particularly adaptable to aircraft and mobile equipment where severe shock and vibration are encountered. The increased operating sensitivity of Model DOSY relay, equipped with twin coils, makes the DOSY adaptable to a wide range of electronic control circuits, such as plate circuit controls. At 115 VAC or 32 VDC, noninductive load, Models DOS and DOSY have contact ratings of 15 amp; Model DO, 10 amp; and Model CRU, 5 amp. Available in a wide range of coil operating voltages and contact combinations.

Current ratings up to 25 amp, AC or DC.
Also made-to-order models in many contact combinations and coil voltages.

HERMETICALLY SEALED OR DUST-PROTECTIVE ENCLOSURES

Be Right with

OHMITE®

RHEOSTATS • RESISTORS • RELAYS • TAP SWITCHES

SEND FOR CATALOG R-11

OHMITE MANUFACTURING COMPANY
(Suburb of Chicago)
3611 Howard Street, Skokie, Illinois

HOW THE SILICONES MAN HELPED...

Build a Gyro for Straight Shooting!

Accuracy that could hit a fly from a screaming roller coaster . . . so rugged that it can be used to drive nails without impairing its operation. That's the "impossible" fire control gyro built by Minneapolis Honeywell, Aeronautical Division. Known as the HIG-5 (Hermetic Integrating Gyro), lightweight and small enough to hold in the palm of your hand, it supplies the "sense of balance" necessary at supersonic speeds.

Operating in a viscous fluid under wide limits of temperature and pressure, seals can be no less than perfect. What material was used? "O" rings of UNION CARBIDE Silicone Rubber.

Fabricated by Moxness Products Company, Racine, Wisconsin, these "O" rings were tested from −65 to +200 deg. F., at simulated pressures from ground level to operational altitudes. Under such rigid tests, UNION CARBIDE Silicone Rubber showed outstanding sealing qualities and resistance to compression set.

This is another example of how the UNION CARBIDE Silicones Man has helped solve an "impossible" problem. A booklet—"Look to UNION CARBIDE for Silicones"—describes silicone rubber and many other silicone products. Write Dept. PD-3 today. Silicones Division, Union Carbide and Carbon Corporation, 30 East 42nd Street, New York 17, N. Y.

UNION CARBIDE
Trade-Mark
SILICONES

The term "Union Carbide" is a trade-mark of UCC.

In Canada: Linde Air Products Company, Division of Union Carbide Canada Limited, Toronto.

FENWAL'S THERMOSTATS NOW CIGARETTE SIZE

Some Units Smaller Still

Take Little More Room Than Sugar Lump

ASHLAND, MASS. — If you want to control temperatures in tight spots, you should see Fenwal. Fenwal has cut the size of thermostats way down.

You can fit one of their Midget THERMOSWITCH units anywhere a cigarette will fit. And, if you're working with even less space, one of their Miniature THERMOSWITCH units is what you're looking for. The Miniatures are little bigger than a lump of sugar, and some are even smaller.

The Midgets and Miniatures use the same unique principle used in Fenwal's bigger THERMOSWITCH controls. They use it with the same high degree of success.

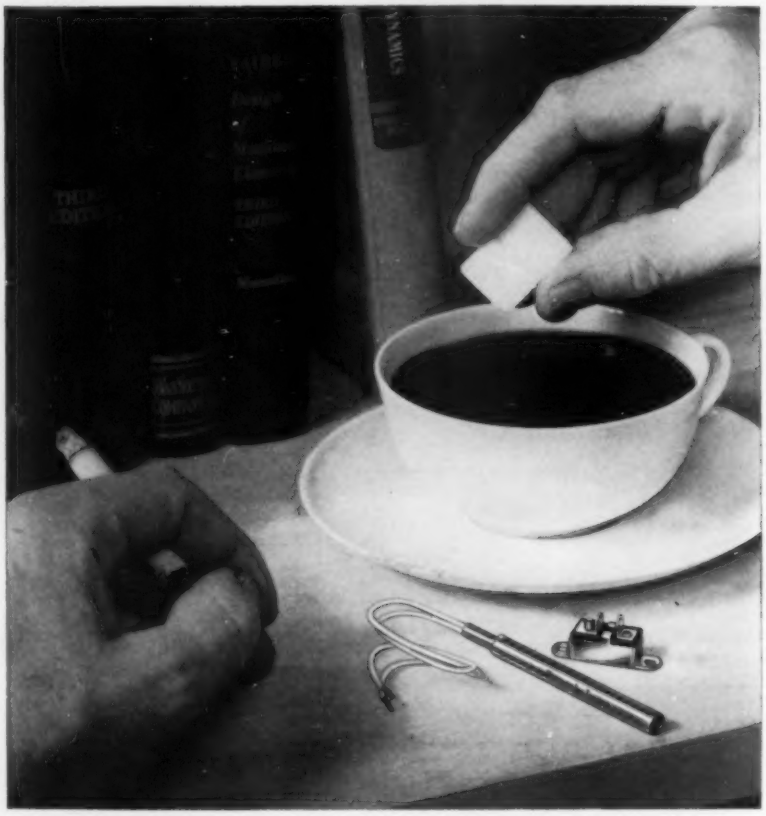
The principle of all Differential Expansion THERMOSWITCH units, large or small, is this: a single metal shell expands or contracts with temperature changes, making or breaking totally enclosed electrical contacts.

The smallness of the Midget and Miniature units does not deprive them of any of the performance characteristics that have made larger THERMOSWITCH units famous. They have THERMOSWITCH ruggedness, THERMOSWITCH accuracy, and reasonable THERMOSWITCH prices.

Temperature range of the Midget series: −50°F to 500°F. Range of the still smaller Miniature series: −20°F to 275°F.

Midgets and Miniatures, all in stainless steel, come in a variety of mountings. Hermetic sealing is also available.

These Fenwal THERMOSWITCH units are precision-engineered to give optimum temperature control with minimum-sized devices. They remain accurate under the most severe operating conditions.



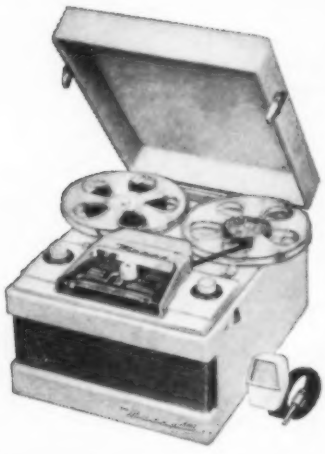
THERMOSTATS FOR TIGHT SPOTS — A Fenwal Midget THERMOSWITCH® unit and a Fenwal Miniature THERMOSWITCH unit — two good answers to the question, "How can you install an accurate, reliable thermostat where there's almost no room?" Actual sizes of these particular models — ¼" x 2 25/32" for the Midget; 1" x ½" for the Miniature.

You should have details on this advance in temperature control at your fingertips. Write for information to **Fenwal Incorporated, 24 Pleasant Street, Ashland, Massachusetts.**

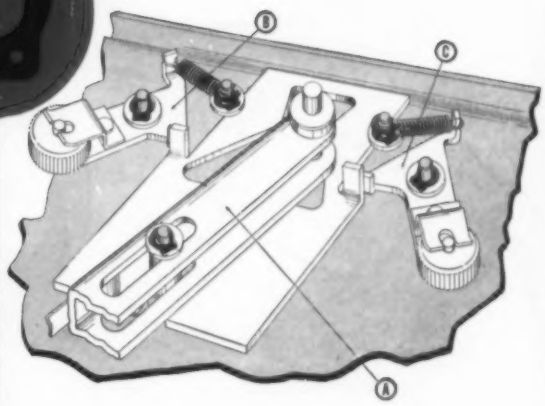
Fenwal

CONTROLS TEMPERATURE ...PRECISELY

Waldes Truarc grip rings used on die-cast studs eliminate threading, tapping, other costly machining



Mark Simpson Manufacturing Co., Long Island City, N. Y., uses Waldes Truarc series 5555 Grip Rings to secure parts to studs of the zinc die-cast base of its "Masco 500" portable tape recorder.
The rings—which need no grooves—replace nuts, screws, cotter pins and other types of fastening devices which require threading, tapping, drilling and other expensive machining operations. Because a single cracked or broken stud would render the entire cast base useless—and with it, all assembly completed to that point—the rings also eliminate extremely costly rejects.



Pivot Assembly of shift lever (A) is secured by a single Waldes Truarc Grip Ring and washer. Because the washer must be installed over the shift level in a sliding fit, critical tolerances would have to be maintained if a screw or cotter pin were used. The Truarc Grip Ring eliminates that problem: it requires no groove and may be seated over the washer at any point on the stud, automatically compensating for accumulated tolerances in the parts. BRAKE ASSEMBLIES (B and C) use Grip Rings to secure the brake wheel and spring subassemblies. Here again problems of critical tolerances are avoided and expensive rejects eliminated.

Whatever you make, there's a Waldes Truarc Retaining Ring designed to improve your product... to save you material, machining and labor costs. They're quick and easy to assemble and disassemble, and they do a better job of holding parts together. Truarc rings are precision engineered and precision made, quality controlled from raw material to finished ring.

36 functionally different types... as many as 97 different sizes within a type... 5 metal specifications and 14 different finishes. Truarc rings are available from 90 stocking points throughout the U. S. A. and Canada.

More than 30 engineering-minded factory representatives and 700 field men are available to you on call. Send us your blueprints today... let our Truarc engineers help you solve design, assembly and production problems... without obligation.

For precision internal grooving and undercutting... Waldes Truarc Grooving Tool!

WALDES
TRUARC®
RETAINING RINGS
WALDES KOHINOOR, INC.
47-16 AUSTEL PLACE, L. I. C. 1, N. Y.

Waldes Kohinoor, Inc., 47-16 Austel Place, L. I. C. 1, N.Y.
Please send the new supplement No. 1 which brings Truarc Catalog RR 9-52 up to date.
(Please print)

Name _____
Title _____
Company _____
Business Address _____
City _____ *Zone* ____ *State* _____

PN 039

WALDES TRUARC Retaining Rings, Grooving Tools, Pliers, Applicators and Dispensers are protected by one or more of the following U. S. Patents: 2,382,948; 2,411,426; 2,411,761; 2,416,852; 2,420,921; 2,428,341; 2,439,785; 2,441,846; 2,455,165; 2,483,379; 2,483,380; 2,483,383; 2,487,802; 2,487,803; 2,491,306; 2,491,310; 2,509,081; 2,544,631; 2,546,616; 2,547,263; 2,558,704; 2,574,034; 2,577,319; 2,595,787, and other U. S. Patents pending. Equal patent protection established in foreign countries.

Cut Hydraulic Flow Resistance . . . Specify HYDRALUSTER the Only "rifle-barrel" Tubing

AXIOM: The smoother the surface, the less resistance offered. And here you see the inside of a section of HYDRALUSTER tubing . . . photographic proof of a super-smooth surface.

Hydraluster is a cold-reduced, carbon steel tube for hydraulic and diesel application. Its exclusive finish is the reason that systems using Hydraluster are developing the highest rates of power efficiency and reaction time.

Hydraluster has other advantages to offer the Original Equipment Manufacturer. Hydraluster is highly resistant to oxidation, even under the conditions imposed by the newest, high-speed fluids. The result is greatly improved maintenance records. And the bright exterior finish of the tubing adds to the appearance and sales appeal of precision machinery.

Produced in standard hydraulic sizes, Hydraluster is a premium tube sold at standard hydraulic tubing prices.

SAMPLES and SPECIFICATIONS: Make the "rifle-barrel" test yourself. Your name on a company letterhead will bring specifications, literature and a sample of Hydraluster by return mail.

Summerill **Tubing Company Division-Columbia Steel & Shafting Co.**

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District Offices: Buffalo • Chattanooga • Chicago • Cleveland
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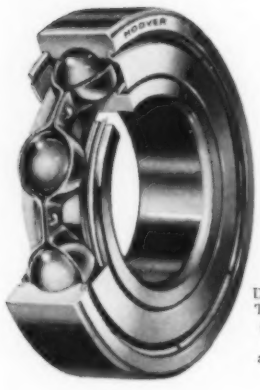
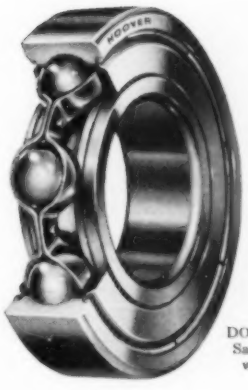


DOUBLE SEAL—
Teflon contact seal shown. Available with snap ring and with single or double seal.



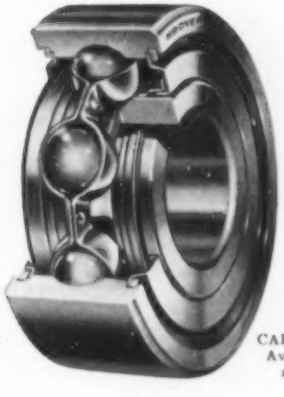
DOUBLE SHIELD—
Same sizes available with single shield.

SINGLE ROW RADIAL—
Also available with snap ring.

when you want quality

COMBINATION FELT SEAL AND SHIELD—
Either standard or wide outer ring.

DOUBLE ROW—
Available with single shield.



CARTRIDGE—
Available with snap ring.

you want hoover

When you want *quality* bearings to add to the performance, long life and smooth operation of your products, you want Hoover Ball Bearings.

Hoover Ball Bearings combine the exactness of *Micro-Velvet* Lapped Balls with the smoothness of *Hoover Honed* Raceways. The result . . . top quality bearings that assure unexcelled performance —quietness—long life—and heavy load capacity.

Investigate Hoover's line of ball bearings in the light, medium and heavy series. Their microscopic precision adds up to your best buy in ball bearings. Manufacturers are invited to call in Hoover engineers for technical assistance. Write for information.

Micro-Velvet and *Hoover Honed* are Hoover Trademarks.

HOOVER BALL AND BEARING COMPANY, ANN ARBOR, MICHIGAN

Send information about

- ☐ Single Row Radial Bearings
- ☐ Bearings with Shields
- ☐ Bearings with Seals
- ☐ Combination Shield and Seal
- ☐ Cartridge Bearings
- ☐ Double Row Bearings

Hoover Ball and Bearing Company, Ann Arbor, Mich.

Please send information checked. Mail copy of "Hoover Handi-Book of Anti-Friction Bearings."

Name_____

Title_____

Company_____

Address_____

City_____ State_____

10

Easy does it. **At tagging station on Alaskan beach, a member of U. S. Fish & Wildlife Service steadies a three-month-old seal pup while companion attaches a corrosion-resisting Monel alloy tag to left flipper. Tagging permits tracing of seal migrations to various parts of the world, aids in scientific studies of growth, mortality, homing instinct and other characteristics.**

Tagged...for future reference

This little seal may be planning a trip far from his Alaskan home. But of course he can't tell the U.S. Fish & Wildlife Service what his destination is!

As they're very much interested in finding out, they tag him.

Migratory habits of seals have been under observance for many years. In all that time, there was one thing that always stumped the Wildlife Service—marking a seal so that he *stayed* marked.

They tried everything they could think of. Clipping...shearing...branding...painting. Nothing worked. When they tried metal tags, that brought up still another problem.

What metal would stand the abuse? What would resist corrosion from salt water? What would be hard enough to resist abrasion when seals clamber over rocks and sand?

Finally, a metal was found—Monel* nickel-copper alloy!

With Monel, it makes no difference if seals frolic in the salty sea. Or flip-flop around on shore. Or travel from Alaska to Japan, as many of them have! Monel alloy tags proved rugged enough to take this punishment. Some, in fact, remained in good condition *after 12 years on a seal's flipper.*

Do you have a problem involving metals? One in which corrosion, abrasion, high or low temperatures, stresses, or fatigue are causing trouble? Look into the Inco Nickel Alloys. Properties are described in a helpful booklet: *Standard Alloys for Special Problems.* Illustrated with more than 40 case histories. Write *now* for a copy. The International Nickel Company, Inc., 67 Wall Street, New York 5, N. Y.

*Registered trademark

INCO TRADE MARK

INTERNATIONAL NICKEL

Nickel Alloys Perform Better, Longer

ALLENPOINT will give you a bulldog grip at no premium in price!

Allen's scientific redesign of the cup diameter on set screws gives greatly increased resistance to *withdrawal* torque. You can count on Allenpoint Set Screws to stay tighter longer, under heavy strain and vibrations. This dependable premium performance of Allenpoints is yours to use without increasing the cost of manufacturing your products.

Uniform Class 3A Threads

Allenpoints' smooth, uniform threads prevent off-lead conditions like Fig. 1. With Allenpoints, you have full, even contact between the engaging flanks of the threaded members (Fig. 2) —and a tight friction lock over the entire length of the Allenpoint Set Screw.

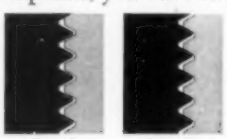


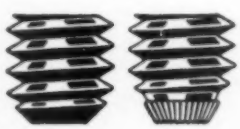
Fig. 1 Fig. 2

Strong, clean, deep sockets allow full wrenching leverage

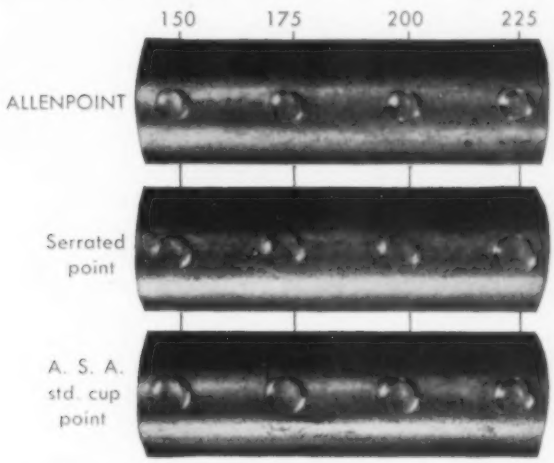
Sockets of Allenpoint Set Screws are cold forged to produce a deeper, smoother socket. No broach chips to interfere with proper seating of the key. This "pressur-forming" preserves the long steel fibers throughout the length of the screw—stronger walls allow maximum tightening torque.

One more full thread on ALLENPOINTS!

Allenpoint Set Screws have one more full thread than serrated point set screws. That means more holding power—especially important when you're using short lengths.



ALLENPOINT's performance compared for you



These actual-size, unretouched photographs show the cup pattern made by Allenpoints, serrated points, and A.S.A. standard cup point set screws in a 3/4" steel shaft. At each degree of tightening force, Allenpoints make a full circle pattern, penetrating deeper for greater holding power.

We'll be glad to send you more information and samples of Allenpoint Set Screws and other Allen Socket Screw products.

Stocked and sold by leading industrial distributors everywhere

ALLEN MANUFACTURING COMPANY
Hartford 2, Connecticut, U. S. A.

ALLEN HEAD HEX-SOCKET SCREWS

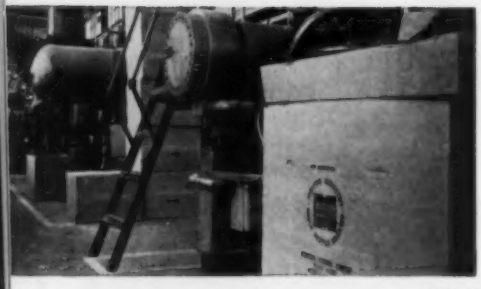
Craftsmanship of the 20th Century

MONSANTO

Speeding the development of many new products is the availability of a wide range of plastic materials with highly usable combinations of properties. In the creative hands of custom molders, these plastics are translating manufacturers' plans and ideas into highly serviceable finished products. Read how one of America's foremost electrical manufacturers teamed with a custom molder to produce an unusually efficient and attractive louver-diffuser.

Lustrex styrene plastic and the sight-saving secret of the new Guth Gratelite

DESIGN OBJECTIVES. To design a shadowless lighting system providing comfortable diffusion, low brightness and efficient illumination, yet possessing the physical shallowness required by the architectural trend to lower ceilings.



MATERIAL SPECIFICATIONS. The "answer," designed by Edwin F. Guth, Sr., was the Guth Gratelite, a translucent plastic grid with ⅜" "sight-saving" cubical openings. The grid sizes: 10⅞" x 48" and 16" x 48". The plastic: Lustrex, Monsanto's styrene. The choice of Lustrex was dictated by many appearance, functional, and production factors which Prolon has skillfully utilized. The spoilage factor in molding Gratelites of Lustrex is unusually low. Lustrex has release properties necessary for molding a multi-ribbed unit without fear of sticking or fracturing upon removal from the mold. It has the excellent flow characteristics to fill the 3,850 sections that form the open squares of a Gratelite louver. The color stability of Lustrex produces the brightness and even light distribution specified by Guth. Lustrex has unusual strength in thin cross sections. Lustrex louvers are easily washed clean without loss of luster; they are rigid, light in weight, warp-resistant.

PRODUCTION. Prolon Plastics, Florence, Mass. molds the Gratelites in 400 oz. Watson-Stillman Injection presses. Good craftsmanship combined with the right materials permits rapid molding cycles on these 48" long louvers. Pre-plasticizer is used and the molding powder is Lustrex Hi-Flow 77.

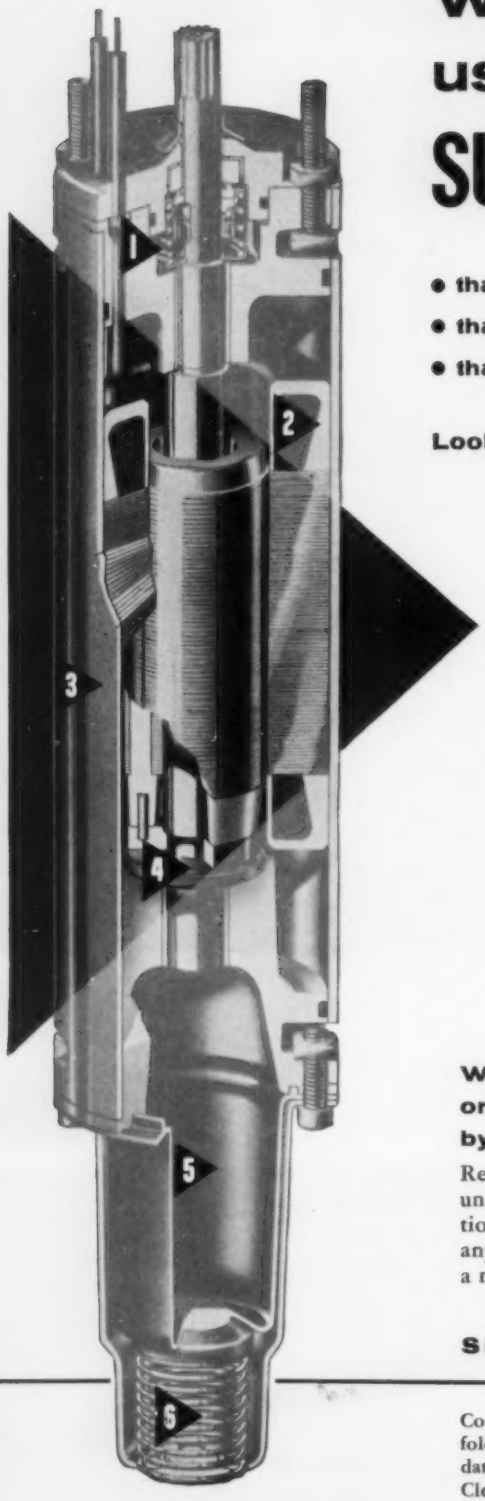
THE FINISHED PRODUCT. In the past 5 years, hundreds of thousands of Guth Gratelites have been installed in offices, stores, banks, and factories throughout the world. Delicate white in appearance, tough and efficient in operation, these louver-diffusers are contributing to restful illumination wherever they are used.

The Gratelite is one of hundreds of design and production problems solved through the utilization of the skills and experience of the plastics custom molding industry. As a major supplier of plastic resins, Monsanto is in a position to introduce you to custom molders who are ready to work with you on product development and improvement. Write to Monsanto Chemical Company, Industrial Applications Dept., Room 2066, Springfield 2, Mass.

Investigate the Monsanto completely-balanced line of styrene plastic compounds developed for particular applications and sold under the trade name . . .

LUSTREX
Styrene Plastic

MONSANTO



Where can you use a *CUSTOMIZED* SUBMERSIBLE MOTOR?

- **that can be made in any length-diameter ratio?**
- **that gives high output?**
- **that runs in water, oil, or other fluids?**

Look at typical features of a J&H Underwater Motor

1 *Rotary Seal*—Ceramic and graphitar faces, carefully lapped to insure against entry of water and contaminants.

2 *Encapsulated Windings*—A special J&H epoxy compound is used for "potting." Epoxy has exceptional heat conductivity and does not buckle or swell under many abnormal conditions. "Potting" prevents winding failure, even if water enters motor. In fact, motor will operate as water-filled unit.

3 *Corrosion-resistant Epoxy Paint Finish.*

4 *Segmented Tilting-shoe Self-aligning Thrust Assembly*—Ample reserve thrust carrying capacity is provided. Faces accurately lapped for long wear.

5 *Oil-filled Motor*—A large reservoir of oil provides additional dielectric strength, insures longer seal and bearing life, protection against corrosion.

6 *Controlled Pressure System*—Diaphragm and spring assembly insures an internal pressure sufficient to prevent infiltration by external contaminants, which could occur with normal seal wear.

- *L/D Ratio To Suit*—Length/diameter ratio can be varied to fit casing, tank, pipeline or other designated location.

Whether you're pumping water, crude oil, gasoline or other fluids, your motor need can be met quickly by Jack & Heintz!

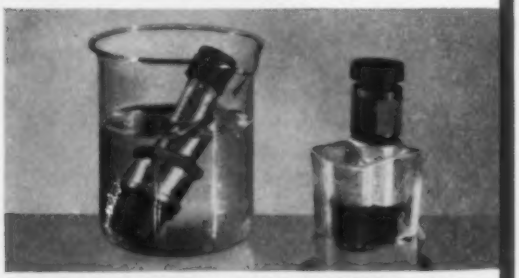
Retaining the size flexibility and long service life features of the underwater motors, J&H designers have already developed modifications for operation in crude oil, gasoline and other fluids. Customizing any of the proved basic designs to meet your specific needs is only a matter of defining your service and dimensional requirements.

SEND FOR DATA TODAY

Confer with J&H motor specialists or write for folder which gives rating and performance data: Jack & Heintz, Inc., 17627 Broadway, Cleveland 1, Ohio.

JACK & HEINTZ ***CUSTOMIZED*** ELECTRIC MOTORS

SEE HOW EASY THEY SLIP ON, AND OFF!
Tapered (non-threaded) CaPlugs can be used as caps or plugs, inside or outside of threaded or plain fittings. Threaded styles are knurled to spin on or off with ease. Costing less to buy, they cost less to apply.



SEE HOW THEY WITHSTAND ACIDS, SOLVENTS, HEAT AND COLD... and keep out dust and moisture, too. Dunk a CaPlugged product in any solution. Subject it to actual process conditions and temperatures. Made of tough, flexible Polyethylene, CaPlugs are impervious to most common chemical reagents, acids and solvents ...retain form stability under stress at temperatures from -94°F. up to 175°F.

SEE HOW TOUGH THEY ARE. For proof, drop a product on its CaPlug...tap it with a mallet...or make a trial shipment of parts with CaPlugs applied. You'll find that these versatile closures provide "kid-glove" protection and will not collapse, chip, break or shred under the most severe of conditions.

SEE HOW EASY IT IS TO GET CaPlugs THAT FIT. By mailing the coupon, you'll receive a free sample of each of the ten different styles which are available in a combined total of over 300 stock sizes. There's a CaPlug that's *right* for practically any closure need. You name it! "Off-the-shelf" deliveries from a 30,000,000 inventory can be made to answer immediate requirements promptly.

see how CaPlugs can protect your products

(IN PROCESS, TRANSIT AND STORAGE)

by testing a free sample assortment like this

YOU'RE INVITED TO TEST CaPlugs in any way you choose. The coupon below will bring a random assortment to your desk...plus illustrated literature, complete details and prices. Reasonable quantities of additional samples in specific sizes for testing are also yours for the asking (details in literature).

MAIL THIS COUPON FOR FREE BOX OF CAPLUGS, DETAILS AND PRICES

CAPLUGS DIVISION, PROTECTIVE CLOSURES CO., INC.
2205-9 Elmwood Ave., Buffalo 23, N. Y.

RUSH a free assortment of CaPlugs, literature and prices to us, without obligation.

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FIRM _____

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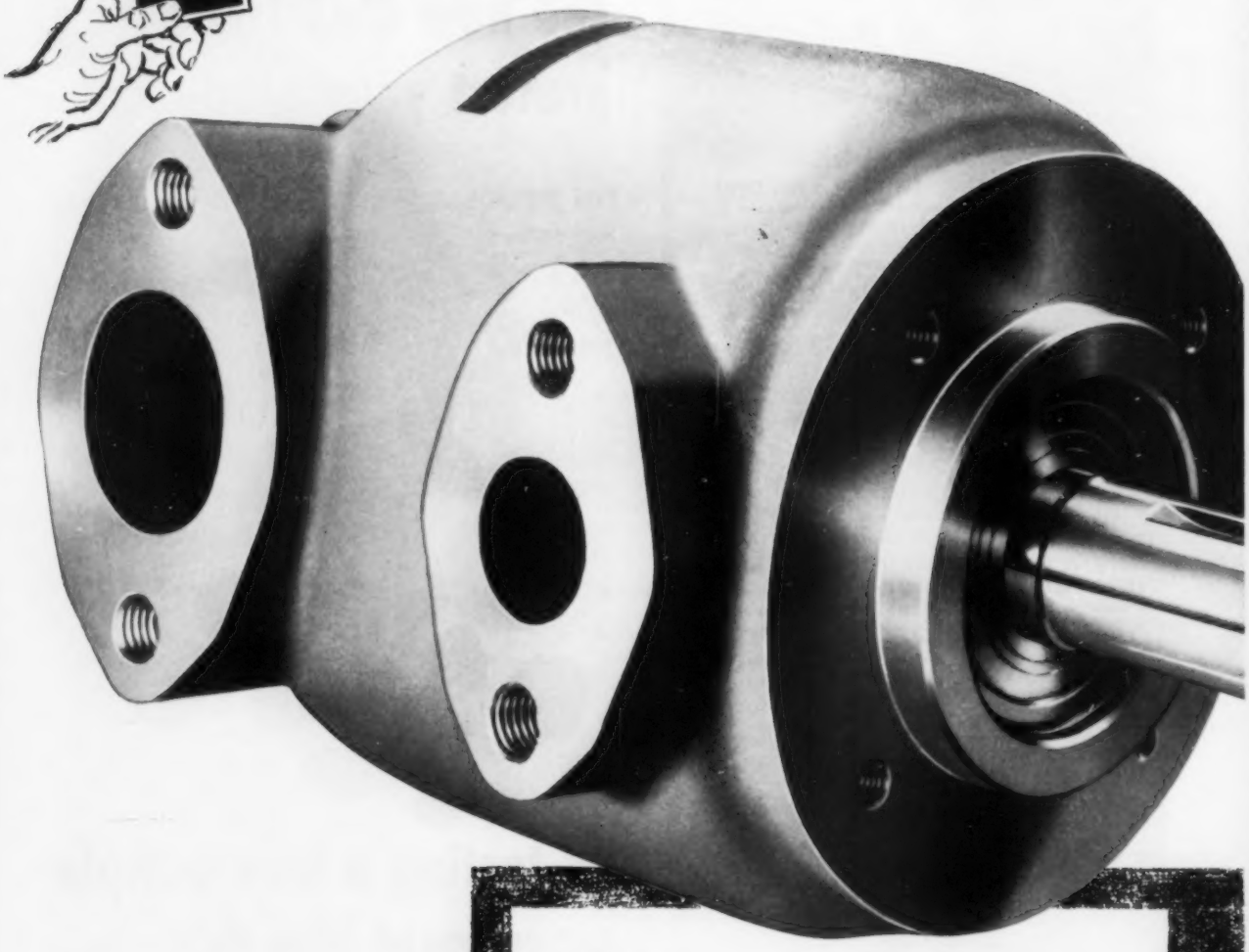
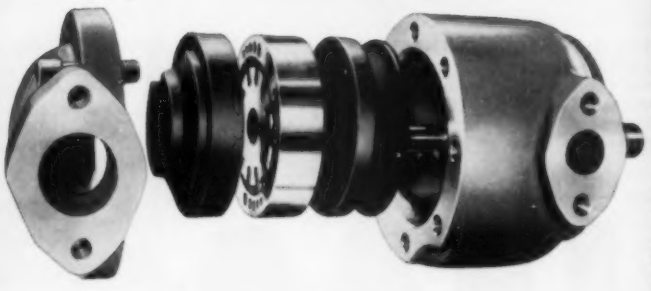
NEW FROM DENISON



For mobile equipment
For special machinery
For automation



Denison's exclusive cartridge construction. *Side plates hydraulically loaded to maintain uniform pressure on rotor regardless of delivery pressure.*

Continuous 2000 psi service in a versatile vane-type hydraulic pump

FOR MOBILE EQUIPMENT, less weight, increased payload

FOR SPECIAL MACHINERY, more power in less space

FOR AUTOMATION, heavy-duty design for low maintenance

● Here are the important features you can engineer into your designs with Denison's new "T" Series balanced vane hydraulic pump.

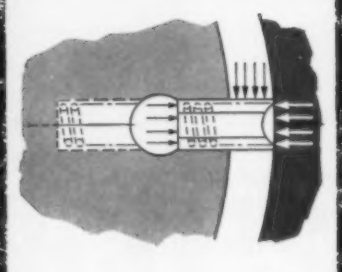
Long, efficient life because Denison's fully-balanced vanes and rotors reduce wear on cam rings and thrust plates to give long pump life with minimum maintenance.

Packs More Power in Less Space. Internal friction is lower, volumetric efficiency is higher. Actually packs 50 h. p. in less space than a conventional 3 h. p. electric motor where space and weight are a premium.

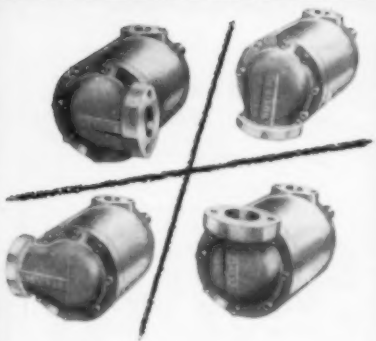
Cold-Weather Starting, under severe weather conditions, to maintain construction schedules.

Fast, Easy On-the-Job Service because the complete pumping cartridge can be removed and replaced as a unit without special tools or skills.

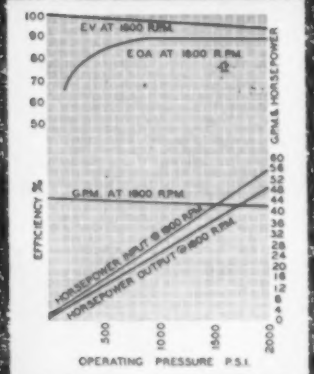
Write for complete engineering specifications in Bulletin 200. Denison Engineering Division, American Brake Shoe Co., 1194 Dublin Road, Columbus 16, Ohio.



***Hydraulically balanced vane construction** cuts excessive wear on vane and cam ring . . . for longer life, higher volumetric efficiency.*



***Universal Mountings** . . . may be mounted in any of four different positions—face, flange or bracket mounted. Operates clockwise or counter-clockwise.*



Performance curve of "T Series" vane-type pump illustrates high volumetric efficiency.

HYDRAULIC PRESSES • PUMPS • MOTORS • CONTROLS

DENISON Hydr**O**il**ics**

MARCH
1957

Dow

Plastiatrics

DOW'S CLINICAL APPROACH TO HEALTHY PLASTICS APPLICATION

PRACTICAL ANSWER TO STATIC DUST COLLECTION

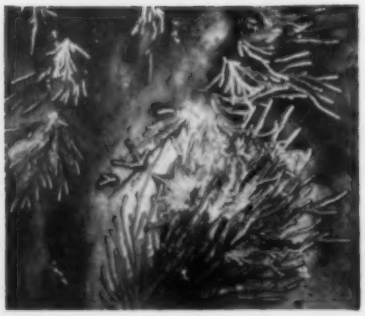


FIGURE 1

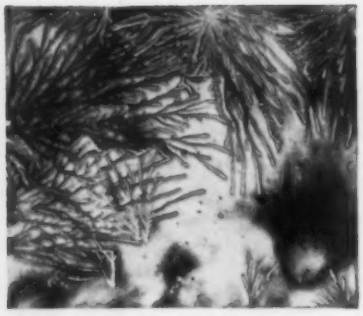


FIGURE 2

FIGURE 3—*Figures 1, 2 and 3 show typical static dust patterns on nontreated plastic surfaces as reproduced by Dow process using fluorescent pigments and "black light".*

DOW RESEARCH SHOWS HOW TO SPECIFY PROPER TREATMENT TO ASSURE DUST-FREE POLYSTYRENE SURFACES

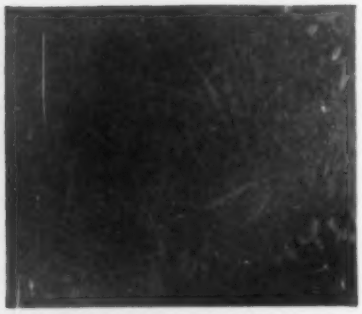


FIGURE 4—*Here the same "black light" technique shows the absence of static charge on plastic surfaces destaticized by new method.*

AMERICA'S FIRST FAMILY OF POLYSTYRENES

GENERAL PURPOSE
- STYRON® 666
- STYRON 665 (Extrusion)
- STYRON 688 (Easy Flow)
- STYRON 689 (Easy Flow)

HIGH IMPACT
- STYRON 475
- STYRON 429 (Extrusion)
- STYRON 777 (Medium Impact)
- STYRON 440 (Heat Resistant)
- STYRON 480 (Extra High Impact)

HEAT RESISTANT
- STYRON 683
- STYRON 700

Static electricity which attracts and holds dust has long been acknowledged a problem in the manufacture and use of plastic products.

To overcome this behavior, Dow Plastics Technical Service developed new techniques for obtaining, observing and recording dust deposits. With these tools, Dow research explored hygroscopic chemicals that render the surface hydrophyllic or, in other words, that destaticize it.

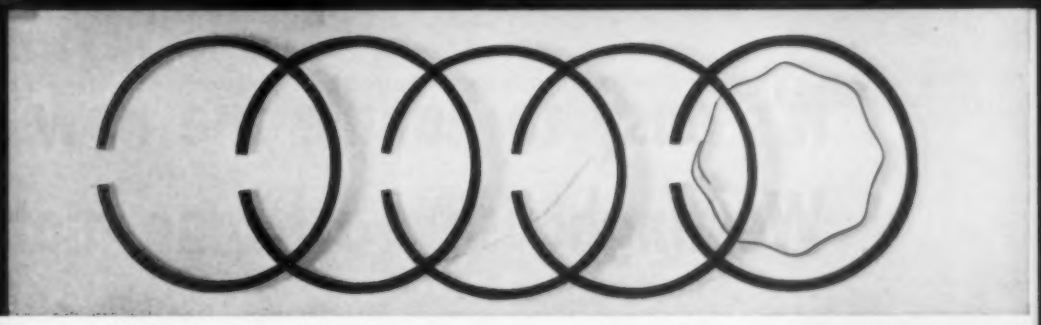
A method was developed and conclusively tested to provide freedom from static for long periods of time. This method includes dipping, spraying or otherwise coating moldings with a dilute detergent solution that reduces electrostatic charges to levels that prevent dust pickup.

FREE BULLETIN

A list of suitable compounds together with further information on this subject are contained in the bulletin, "Static Dust Collection of Plastics". Address: THE DOW CHEMICAL COMPANY, Midland, Michigan—Plastics Sales Department PL1540G.

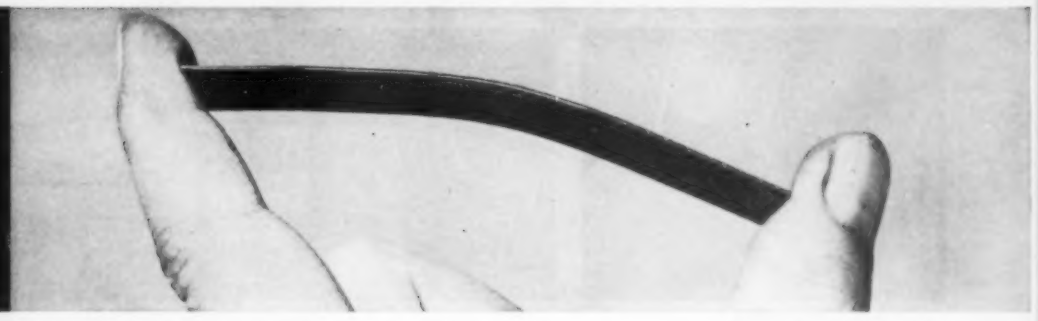
YOU CAN DEPEND ON DOW

1. Do you recognize the value of these 5 rings?

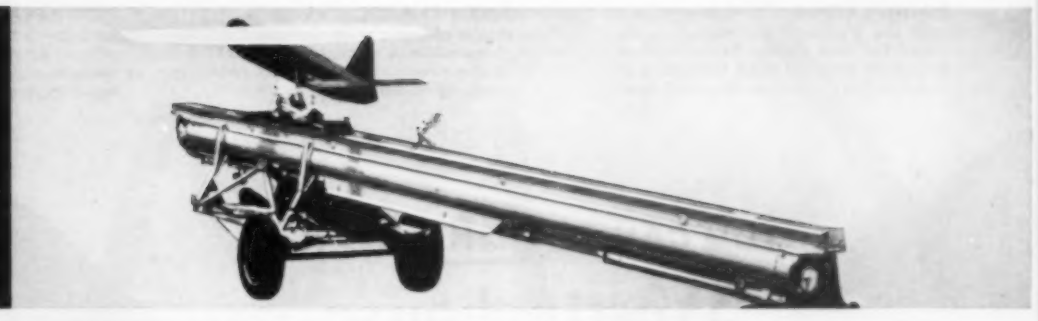


2. What should a compressor have in common with this freight train?

3. It operates with no impact. Can you name the part?



4. What "fires" this Navy target drone?



WHAT'S YOUR C.Q.? (COMPRESSOR QUOTIENT)

1. You recognize these as being compressor piston rings. But perhaps you didn't know that the number isn't always the same. Many manufacturers, for example, use only four rings. Worthington, however, uses five rings – three compression and two oil. For lower oil consumption, less contamination and higher efficiency, learn to recognize the value of these five rings.

2. To cut maintenance costs, railroads are switching to "roller freight." You'll find tapered roller bearings in all Worthington compressors. Not only do they provide lower friction load, but they also can be adjusted to compensate for wear. To get the best make sure you always specify compressors with "adjustable tapered roller bearings."

3. When operating, the valve strip shown above opens and closes with a gentle rolling contact – there's no destructive impact. Replacement is infrequent and unlike many other makes which require replacement of the complete cylinder or head, all Worthington compressors are equipped with individually replaceable valves, valve guards, and valve seats. This feature saves many maintenance dollars.

4. Developed by Van Zelm Associates of Baltimore, the Navy's new mobile catapult is "fired" by compressed air supplied by a 20-hp Worthington compressor. As true in industry as it is in defense whenever men need reliable compressed air they turn to the company with a reputation for performance. Worthington Corporation, Harrison, New Jersey. PC. 7-13

WORTHINGTON

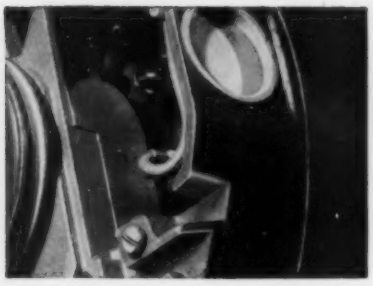
It's easy to handle the new Westinghouse 48-frame motor

These five big mechanical advantages prove it!

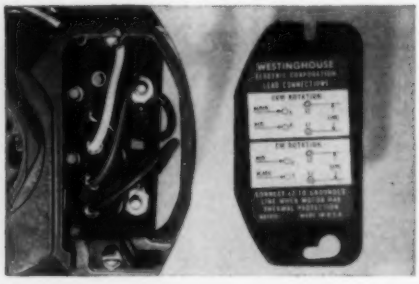
Up to 35 pounds of pull will not disconnect the line cord on this new Westinghouse 48-frame motor. A built-in strain relief, one of this motor's many mechanical features, was designed with you in mind.

The mechanical advantages you get with the new Westinghouse 48-frame simplify your product design problems. They help speed up your assembly—make it easier and less costly. And they assure you of the permanent dependability you need and require to help make *your* product better—more salable.

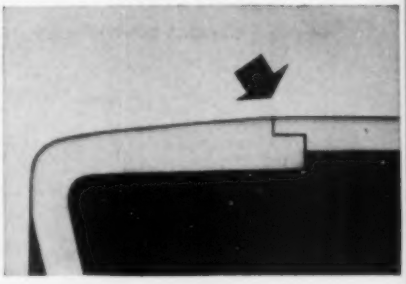
For more information on the mechanical and other advantages of the new, lighter, more compact Westinghouse 48-frame motor, contact your nearby Westinghouse sales engineer. Or, write for descriptive bulletin DB-2801 to Westinghouse Electric Corporation, P. O. Box 566, Lima, Ohio. J-03030-X



POSITIVE CONNECTIONS are assured with the Westinghouse built-in strain relief for line cords. Easy-to-get-at knockout permits quick threading of conduit into spacious terminal box.



SIMPLE CHANGE of voltage and rotation is possible with easily accessible plugs on a modern terminal board. Motor's versatility materially reduces stocking requirements.

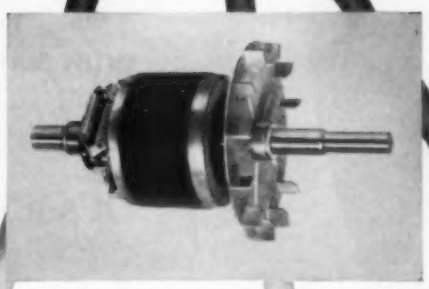


HEAVY FRAME with machined fit for end brackets assures positive alignment. Absence of "Swiss-cheese" vents in solid frame protects windings against liquids or dirt.

YOU CAN BE SURE...IF IT'S

Westinghouse

WELDED FOOT provides an absolutely rigid mounting—assures accurate control of shaft height. Rigid or resilient mounted, these new motors can be operated in any position.



CONTROLLED CONCENTRICITY through use of centerless ground shaft and dynamically balanced, aluminum die-cast, skewed rotor assures even torque and extra-quiet operation.

With National Seals

Quality control isn't a myth— it's a crusade!

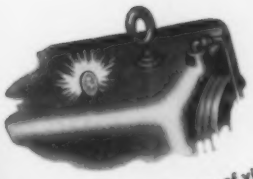
At National, quality control is based on the oil seal industry's most rigid manufacturing specifications. It begins with critical examination of raw materials. It includes constant checking of form tools and molds. It extends to exhaustive optical examination of all seal components by an exclusive process developed at National. (In this process, seals are cast and cross-sectioned, and an optical comparator used to show exact shape and position of every seal part, mounted on the shaft or unmounted.) And always, there are extensive and continuing operating and "leak" tests of finished seals.

For proved dependability, specify National seals. And for prompt, knowledgeable help on sealing problems, call your factory-trained National Seal engineer.

NATIONAL SEAL Division, Federal-Mogul-Bower Bearings, Inc.
General Offices: Redwood City, California; Plants: Van Wert, Ohio, Downey and Redwood City, California

National Field Engineers At Your Service: Chicago, Ill., Room 462, McCormick Building, HArrison 7-5163
Cleveland, Ohio, 210 Heights Rockefeller Bldg., YEllowstone 2-2720 • Dallas, Texas, 2520 West Mockingbird Lane, FLeetwood 2-7541
Detroit, Mich., 13836 Puritan Avenue, VErmont 6-1909 • Indianapolis, Indiana, 2802 North Delaware St., WAlnut 3-1535
Milwaukee, Wis., 647 West Virginia Street, BRoadway 1-3234 • Newark, N. J., 1180 Raymond Blvd., MItchell 2-7586

4052



To demonstrate absence of vibration, a quarter was placed on the Cleveland unit. It remained upright through continuous clutching and declutching cycles and was still standing next morning after an overnight run-in test. Drive pictured at left was built by the Patton Mfg. Co., Springfield, O.

CLEVELAND-equipped mill drive offers vibration-free operation

IN a paper mill it is important that the output shaft of the gear reducer deliver smooth power to the paper-making machine. If this is not the case, the very sensitive draws between sections of the machine will not be maintained and the sheet of paper will break, causing an appreciable production loss.

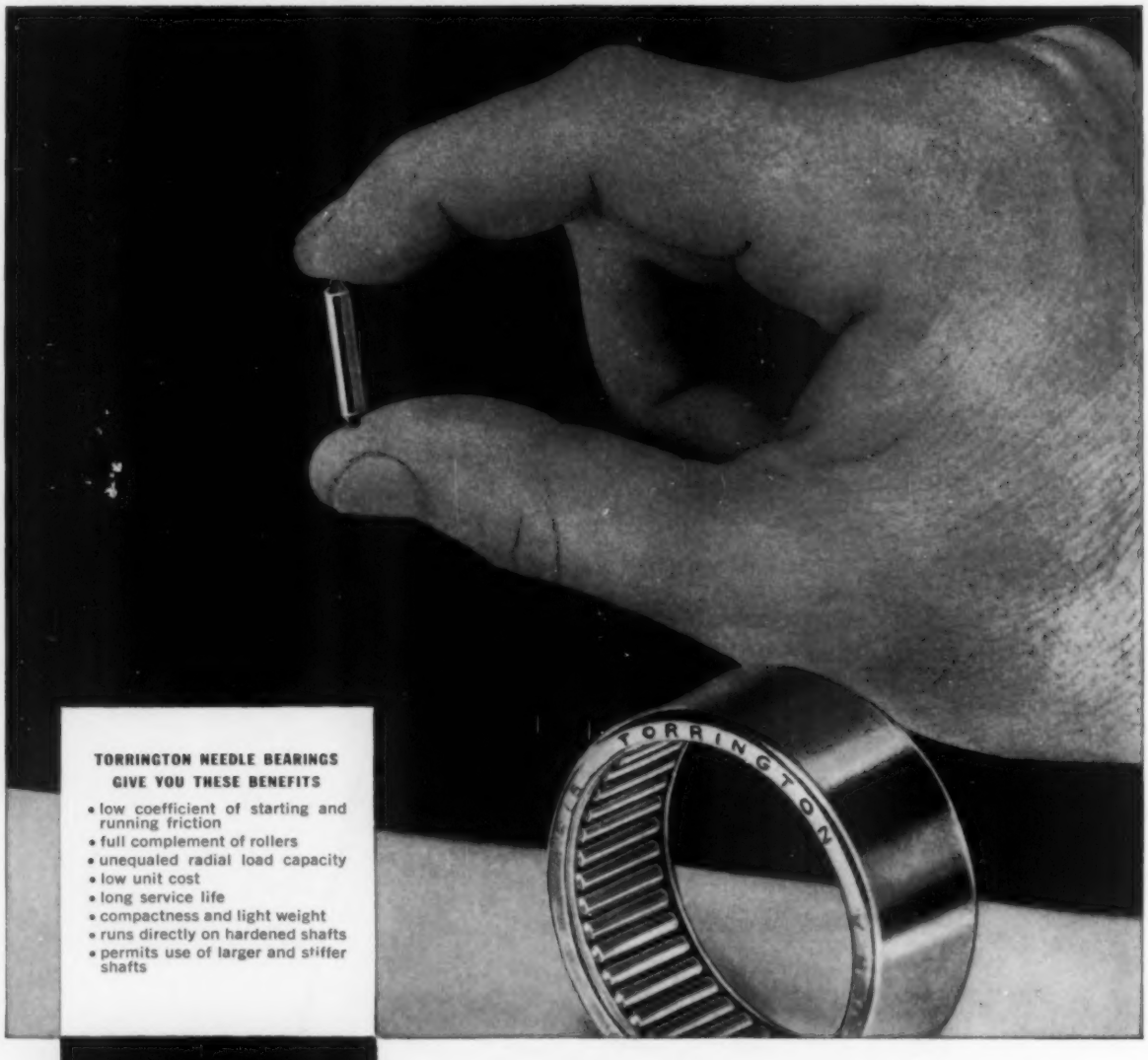
In this new machine drive, smooth vibration-free power delivery is insured by its rugged transmission unit—a Cleveland Worm Gear Speed Reducer. Both drive makers and users know from years of experience that any Cleveland will transmit power from motor to its driven machine smoothly, quietly, continuously, dependably.

So wherever you need compact, right-angle speed reducers that will serve dependably under all conditions, specify Cleveland, the pace setter in power transmission since 1912.

Write for Catalog 400 and the name of our representative near you. The Cleveland Worm and Gear Company, 3279 East 80th Street, Cleveland 4, Ohio.

Affiliate: The Farval Corporation, Centralized Systems of Lubrication. In Canada: Peacock Brothers Limited.

CLEVELAND
Worm Gear
Drives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GIVE YOU THESE BENEFITS
• low coefficient of starting and running friction
• full complement of rollers
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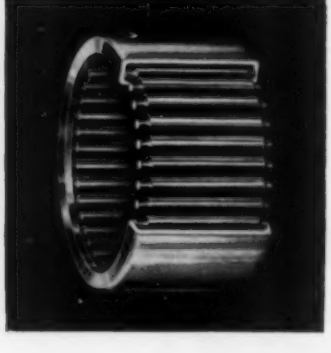
• low unit cost
• long service life
• compactness and light weight
• runs directly on hardened shafts
• permits use of larger and stiffer shafts
TORRINGTON



Close-up of precision!

This Needle Roller, key to the operation of the Torrington Needle Bearing, is a microscopically precise example of Torrington craftsmanship.

In every manufacturing step, from selection of bearing materials to final polishing, these rollers are checked with strict quality control.

A full complement of rollers, mounted in a precision-made, case-hardened retaining shell, provides a maximum number of contact lines, giving the Torrington Needle Bearing a higher radial load capacity than any other anti-friction bearing of comparable size. Rollers operate smoothly with low coefficient of starting and running friction.

Torrington's experience with Needle Bearings spans the history of their development for thousands of successful applications. In seeing that you get every last ounce of performance these unique bearings can deliver, your Torrington representative is an expert: call on him at any time. *The Torrington Company*, Torrington, Conn.; South Bend 21, Ind.

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"CLICK" lubrication starts when machine starts!

ALEMITE OIL-MIST AUTOMATIC LUBRICATION

provides constant, foolproof uniform lubrication— to protect *any* moving surface!

Alemite Oil-Mist lubrication can be easily designed into any new or installed machine. This simple, continuous, completely automatic system eliminates human error—multiplies bearing life—reduces product spoilage—boosts machine output! Operates on compressed air . . . starts and stops when machine switch is turned on and off. Airborne lubricant is conveyed through tubing to bearings. Mail coupon below for full details about Alemite Oil-Mist. Now in use on modern, high-speed machines.

Lubricates any bearing on any machine with one of three types of fittings:

Mist fittings for roller, ball, needle—or any anti-friction type of bearings.

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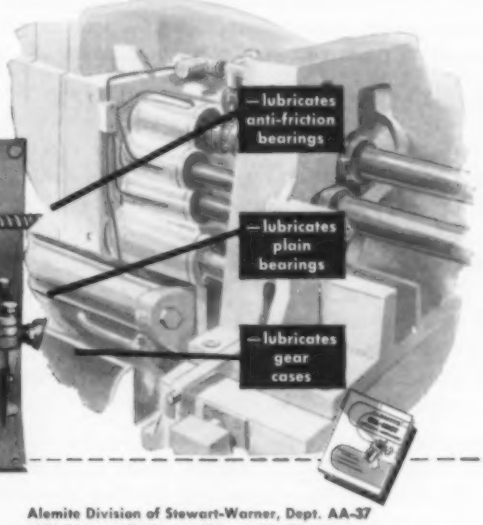
Condensing fittings for plain bearings, slides, ways, vees, cams, and rollers.



8 Advantages of the Alemite Oil-Mist System

1. Continuous lubrication. Deposits fresh, clean film of oil on all surfaces of all bearings.

2. Fully automatic. Starts and stops with operation of machine switch.

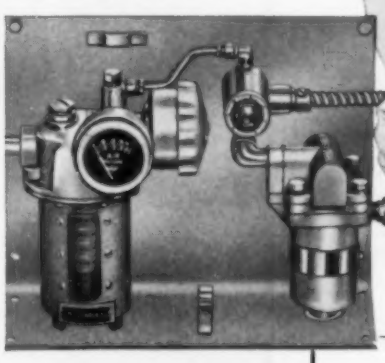
3. No guesswork. Bearings can't be overlooked, or over-lubricated!

4. Reduction of bearing temperatures. Acts as bearing coolant. Reduces bearing temperatures as much as 20°F.

5. Fewer types of oil. Reduces number of oils that must be stocked, handled and applied.

6. Elimination of downtime. All bearings are constantly lubricated while machines continue to operate.

7. Extension of bearing life. Life of grinding machine bearings have been extended from 400 to 7,000 hours!



8. As high as 90% less oil consumption. Usually consumes about 1/10th amount used by any other oiling method.

Mail coupon for Oil-Mist demonstration and information

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Alemite Division of Stewart-Warner, Dept. AA-37
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☐ Please send me a FREE copy of your new and complete Oil-Mist catalog.

☐ Please have your Alemite Lubrication Representative arrange a no-obligation demonstration.

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Note—Commercial and Military Packaging Engineers:

LINK-LOCK

...is the rugged answer to your exacting container closure problems

LINK-LOCK plays an important role in the design of this container

Simmons' LINK-LOCK provides pressure-tight, impact-resistant closure, plus quick closing and opening, on this reinforced fibrous plastic product made by the new automatic pre-form process developed by Pressurform Container Corp. The two-section container will be used by the Light Military Electronic Equipment Dept. of General Electric Company for shipping airborne radar jamming units to the Air Force.

Of prime importance are the container's lightness, strength, rust- and mildew-resistance, ability to withstand high pressures without distortion, ease of locking and opening, and low cost.

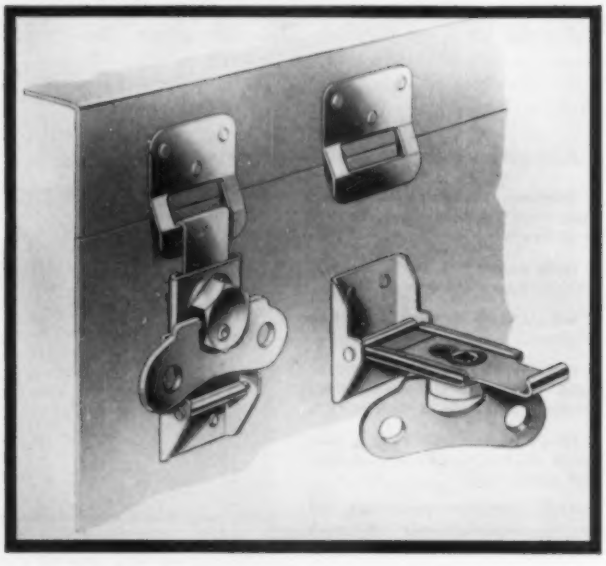
Here's why LINK-LOCK is ideal for use on military cases produced to exacting specifications as well as on inexpensive commercial containers:

- High closing pressure with light operating torque... insures pressure-tight seals where required.
- Impact and shock resistant (positive-locking).
- Compact design... lays flat against case even when unlocked.
- Available in 3 sizes, for heavy, medium, and light duty.
- Opening and closing by wing-nut, screwhead, or hex nut.
- Flexible engagement latch design...can be varied to suit different conditions.

Also available! Spring-Loaded LINK-LOCK... ideal for less expensive containers where costs won't permit precision production. Spring provides take-up to compensate for set in gasketing, irregularities of sealing surfaces, and mounting inaccuracies.

Where does the versatile Simmons LINK-LOCK belong in your design? For full information and specifications, send for LINK-LOCK DATA SHEETS today. Samples and engineering service available upon request.

Courtesy of Pressurform Container Corp., and the LMEE Dept. of General Electric Co.



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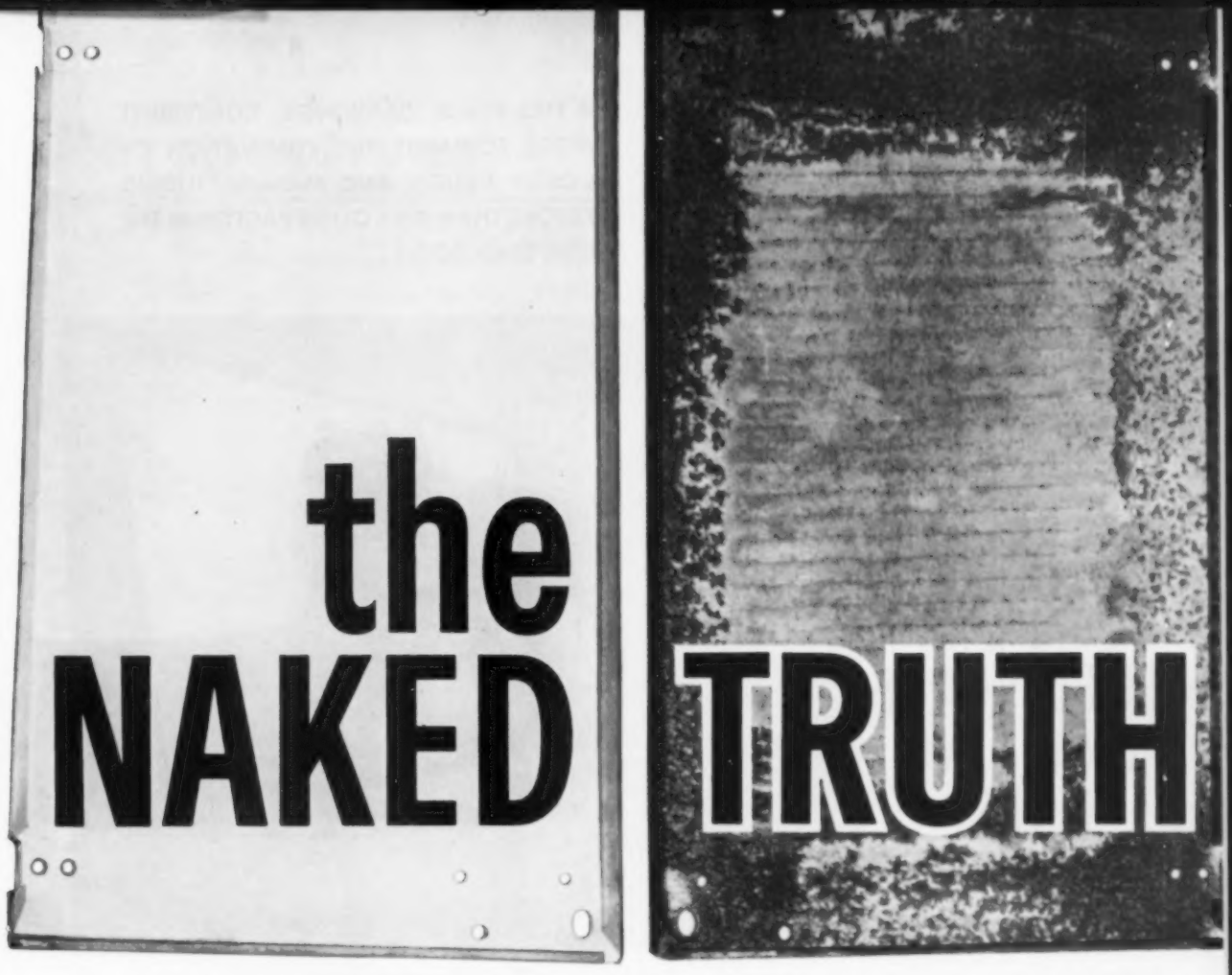
QUICK-LOCK SPRING-LOCK ROTO-LOCK LINK-LOCK DUAL-LOCK



Even after a year's exposure to storms, salt and humidity on a Florida pier a two-piece hollow kitchen cabinet door of Weirzin electrolytically zinc-coated steel remained gleaming bright on the inside, and held its finish beautifully on the outside. Note what happened to the inside of the plain steel door that went through the same test. That's rust and lots of it . . . a completely ruined product both inside and out.

There's a profitable moral for *you* in that story—of a comparison test conducted by a leading manufacturer of kitchen cabinets for its own satisfaction. The moral: You can protect your products right from the start by using Weirzin right from the start. Its skin tight electrolytically fused zinc coating, uniformly applied, takes the toughest fabricating steps without peeling or flaking. Because it *does* stand up under the severest bending, drawing, crimping, flexing, you can forget coating or recoating—and its extra cost.

Furthermore, chemically treated Weirzin takes paint, enamel and lacquer beautifully, holds them indefinitely, eliminates underfilm corrosion.

Send for free booklet . . . get all the facts on Weirzin's many cost-saving advantages. Write to Weirton Steel Company, Dept. D-9, Weirton, West Virginia.

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● **FULL-SCALE DRAWINGS CONTRIBUTE MORE TOWARDS THE ELIMINATION OF COSTLY DESIGN AND MANUFACTURING ERRORS THAN ANY OTHER FACTOR IN THE DRAFTING ROOM.**

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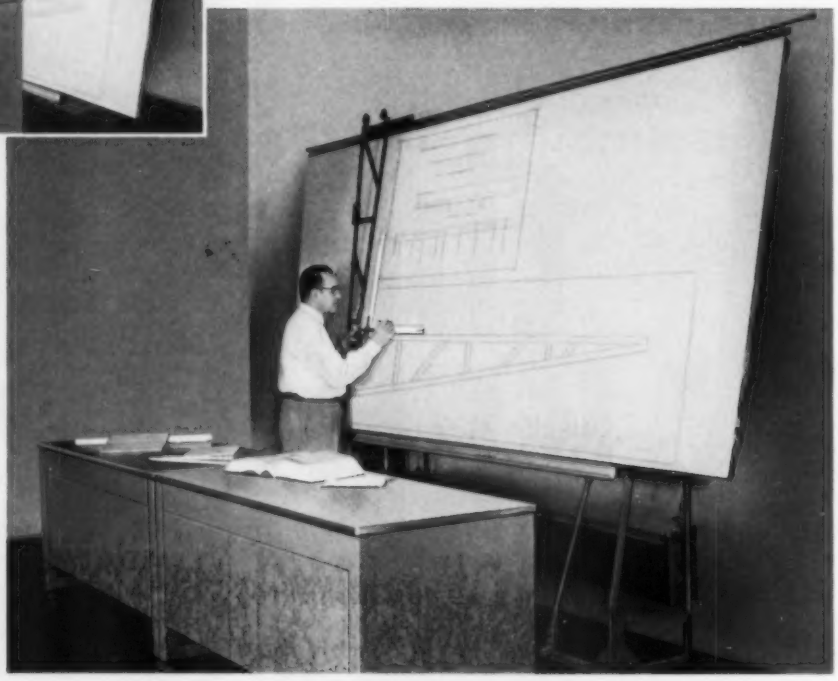
COUNTER BALANCED FULL-SCALE DRAFTING UNITS



Emmert Full-Scale Drafting Units equipped with Emmert Micro-Drafters provide the operator with the most accurate, efficient and easy to use drafting unit ever manufactured. Position changes to any area of the board surface can be accomplished in seconds—there are never any blind spots. Long, continuous, parallel lines, either horizontal or vertical, may be drawn the entire length and height of the board with an accuracy unmatched by any other drafting equipment. The Micro-Drafter's, Micro-matic Quadrant provides rapid indexing from 0° to 360° in multiples of 3° by simple lever action. Settings from 3° to 2½ minutes are quickly made by vernier action. Absolute accuracy of all angles is assured by fine precision tooling.

Perfectly counter-balanced and equipped with self-aligning bearings, the units raise and lower with a smooth gliding action. Once positioned, the unit remains in place without locking . . . there is never any annoying, gradual sinking.

Emmert Full-Scale Units have gained nation-wide acceptance by industry and engineers. In many installations they have effected time savings of 40%

Full-Scale Units are made in 44 standard sizes, from 42" x 72" to 11' x 30', as well as custom sizes to meet any demand. One installation alone employs 15 Emmert Full-Scale Units 7 feet high by 141 feet long.

Both the automotive and airplane industries have been quick to recognize the advantages these Emmert units offer. Won't you write us today and learn how advantageously these units can work for you?

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Please send me the complete EMMERT Story.

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DRAWS THE ACCURATE LINE

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Perspectives

IN DESIGN AND DEVELOPMENT

ENGINEERING JOBS: EASY TO GET?

If the numerous magazine and newspaper employment advertisements are any indication, an engineer has easy pickings. That's what Max A. Pape thought when he decided to make a survey of the situation. The results, as presented in his article in the January 21st issue of *Aviation Week*, are surprising, and, as Mr. Pape says, "We ended up confused and discouraged. We don't feel there is a legitimate shortage of engineers at all."

Using authentic backgrounds, names and addresses of three working engineers and two engineering students, Pape answered 30 magazine advertisements and 75 newspaper advertisements for engineers. The ads, replies and the application blanks forwarded with replies, were studied by 300 working engineers, 200 engineering students, and personnel departments of local and out-of-state companies. These are the results:

- Seventeen resumes were not acknowledged out of the 105 sent to companies all over the U. S.
- Form letters were received in reply to 12 of the 105 applications. Some of the routine letters were not signed, and some not even personalized to the extent of filling in the name and address.
- Only 23 of the replies answered a specific question that had been asked in each of the applications. The remaining 53 that responded forwarded application blanks without answering the question, even when that question was about citizenship.
- Only 14 of the responses were followed up by another letter, and all 14 were companies in the aircraft industry.
- Fifty actual applications for employment were completed and submitted for consideration. Of these fifty: 13 were not acknowledged; three asked working engineers (each having more than 5 years' experience) to take aptitude tests; four prospective employees received follow-through letters written by someone other than the original contact, with no reference made to previous contact or correspondence.
- Sixty-eight of the 75 application blanks examined were inadequate; the wrong questions were asked and not enough space was provided for education, work history, etc.
- Of 31 job offers pending personal interview, 3 were insulting, and 3 cast aspersions on the undergraduate and graduate schools attended.

LARGE COMPANIES NOT ORGANIZED

The survey produced other complaints and confusions. The individual projects of a large company will compete for engineers as if they are individual companies. Instead of one over-all recruitment coordinator who evaluates and places applicants, engineers are expected to make their own evaluations. Pape wrote to as many as five different projects of the same company, received five different replies, five different salary figures, and was offered five different jobs. In some cases he was turned down by four and considered eligible by the fifth.

(Continued on page 129)

"DEPENDABLE for HEAVY LOADS and FREQUENT STARTING"

Reasons Wheeldex uses BODINE MOTORS

Bodine Type NCI-54RL reducer motor

This Bodine motor is used in Wheeldex and Simpla rotating files having loads varying in total weight from around 22 to 364 lbs. Because Bodine Motors have established an outstanding record of reliability under the abusive treatment of frequent starts-stops, plus considerable jogging, they are "standard" on all of the company's motorized files.

A cutaway drawing of the Wheeldex shows the position of the Bodine Motor. The ⅛ HP, 1625 rpm, capacitor start-and-run motor, with a 40:1 gear ratio and 73 in. lbs. torque, is connected to the driving pulley. The high starting torque of these Bodine Motors easily handles the unbalanced loads resulting from partially filled files.

Here is one motorized model of the Simplawheel. Rapid positioning of the file cards quickly brings any one of 1,000 to 120,000 or more cards, depending on capacity of model used, within inches of the operator's fingers for easy finding, posting and filing.

Mr. R. P. Scholfield, general manager, gives the reasons Wheeldex & Simpla Products, Inc., White Plains, New York, has standardized on Bodine Motors for all of their motorized file systems . . .

"Unbalanced loads, amounting at times to an estimated additional force of 140 oz. ft., and an unusually high number of starts and stops makes our application of your motor extremely abusive. However, we have never had a motor failure, and no service or maintenance problems whatsoever over long periods of time."

Be sure your motor is as good as your product. For information contact Bodine Electric Company, 2260 West Ohio St., Chicago 12, Ill.

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...the power behind the leading products

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Bodine manufactures fractional horsepower electric motors for:

adding machines, letter openers, sanders, vending machines, exhaust fans, duplicating machines, hand dryers, portable tools, sound recorders, air conditioners, check protectors, respirators, voltage regulators, X-ray timers, traffic signal timers, stirrers, calculating machines, envelope sealers, and for many other applications.

On answering advertisements placed by companies spending over a million dollars each year in recruitment advertising, in one case it resulted in a form letter refusal saying that the resume had been circulated to all of the company projects. But when copies of the same resume were sent to three projects of that company, three job offers were received.

Some advertisements stressed the opportunity of the engineer to select his location and be placed accordingly. Applications were sent to these companies, but in several instances upon interview it turned out that the job was in another part of the country.

WHAT THE ENGINEERS WANT

Of the 500 engineers and students who were interviewed, almost all said that they would like to select the right company the first time and ten years later be working for that company in an advanced position. It was unanimously agreed by this group that they were not taken in by beautiful brochures. The opinion of a company is based on the way the personnel department handles applications, whether they answer specific questions, and whether there is any indication that the personnel department works with the engineering staff.

It was learned that engineers prefer to work for companies where engineers are in administrative positions, because they feel there will be less chance of wasted engineering talent. Students want to work for an engineer-managed company to avoid being held in "intern" positions. Some companies mention "engineer management" in their ads. Most do not.

OTHER EMPLOYMENT INDUCEMENT

In spite of all the employment angles offered—location, climate, housing, company benefits, etc.—the engineers say that there are other ways to lure them to new jobs. For example: instead of a large taxable salary, why not a small taxable salary, and a large non-taxable per diem? Profit sharing plans? Stock purchase plans with the company matching one-for-two, or one-for-ten, depending on market values? Company automobiles for private use?

WHAT THE COMPANIES SAY

Product Engineering attempted to elicit opinions from several companies, large and small, on many of the points raised in the article. However, all but one refused to answer. And when followed up by telephone calls, the companies refused to inject themselves into the controversy. One employment manager of a medium-sized company in stating his views did say that the article had wide readership, as evidenced by the many comments made by engineers in his own company. He said, "On the whole, Mr. Pape's remarks were true, but he does not have a full picture of the problem. Hiring engineers is no easy task. We get at least 50 resumes for employment each day, and it requires a sizeable personnel staff to process them. Engineers should expect this. There is a definite time element involved at this point but engineers cannot wait. If the company has several divisions, it takes time to circulate the resumes, and by this time the prospective employee is working elsewhere. Of the approximately 50 resumes that we get each day, about four are of sufficient interest to warrant

(Continued on page 131)

Design data on adhesives

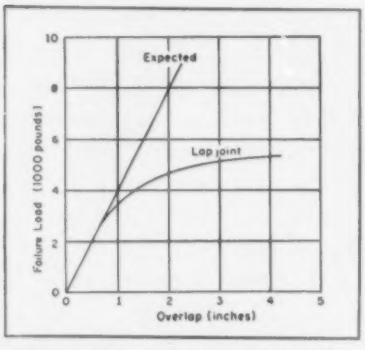
Armstrong

ADHESIVES • COATINGS • SEALERS

NUMBER SEVEN

How to increase the strength of a lap joint

The shear strength of a metal-to-metal lap joint is directly proportional to the width of the joint. For example, by increasing the width from 1 inch to 2 inches (with depth of lap and gage of metal held constant), the strength is doubled.



Relationship between failure load and overlap.

Strength may also be increased by increasing the depth of overlap. In this case, however, the relationship is not linear. Since the edges of the lap carry a relatively higher proportion of the load than the interior portion does, the *unit* increase in strength gradually lowers as overlap becomes greater.

You can also increase the strength of a lap joint by increasing the thickness of the metal. In fact, unless the metal is of sufficient gage, its yield strength will be lower than the shear strength of the adhesive, even at relatively short overlaps.

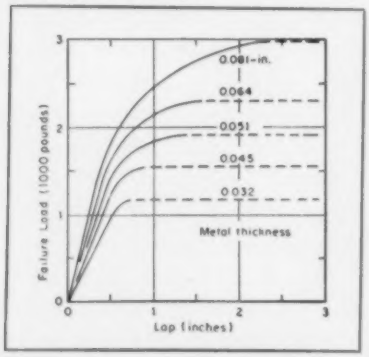


Chart shows interrelation of failure loads, depth of lap and metal thickness for lap joints with a specific adhesive and metal.

Bonding metal to metal

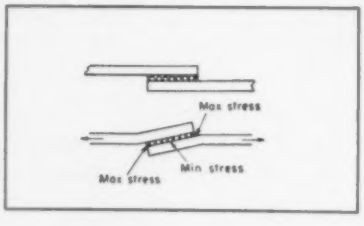
Joint Design

Two of the major factors influencing the design of an adhesive-bonded metal-to-metal joint are the magnitude and direction of the load the joint will have to bear. Most of the adhesives used for bonding metal to metal are relatively rigid, strong in shear, and not so strong in peel or cleavage. Thus, by designing the joint so that the adhesive is in shear, the effect of peel or cleavage stress is minimized.

The most common method of assembling flat metal plates or sheets is through the use of the straight lap shear joint.

Loads Carried by Joint Edges

When a metal-to-metal assembly is in tension, there is a tendency for the edges of the lap to deflect. This is because the stress in each sheet is at a maximum where it enters the joint. (See illustration)



Although the adhesive appears to be in shear, this deflection actually sets up tensile stresses at the edges of the lap, which tend to peel the bond apart. As a result, loads which can cause such an assembly to fail are often substantially below the true strength of the adhesive.

It follows, then, that a high proportion of the load in lap joints is carried by the edges of the lap. This can be illustrated by bonding a 1-inch lap joint with only ¼-inch strips of adhesive on each edge. Such an assembly, bonded with an adhesive with an apparent strength of 3000 psi, will take a 2500 psi load before failure—even with the interior ½-inch of the lap not contributing to the bond. Because the edges bear so much of the load, it is extremely important to get a good bond at these points.

Thickness of Adhesive

The strength of most metal-to-metal joints depends on the thickness of the adhesive film. Although it is commonly believed that the strongest joints are made with the thinnest films, certain types of adhesives show little difference in shear strength over a relatively wide film thickness range—.0005″ to .010″, for example. The optimum film thickness may be different for each adhesive and the manufacturer's recommendation should be followed.

The most effective thickness of adhesive film depends largely on the type of stress the joint must withstand. Difficulties from creep, for example, may be greater with thicker adhesive films. On the other hand, heavier film thicknesses often improve impact and peel resistance, while relatively thin adhesive films can show the highest shear strength.

In all cases, the mating surfaces must be free of grooves, slots and waviness, and protuberances or bosses that may interfere with attainment of optimum film thickness.

BONDING METAL TO METAL Here, stiffening members are being bonded to a wall panel on an assembly-line basis.

For more information

Write for a copy of "Armstrong Adhesives, Coatings, and Sealers." Armstrong Cork Company, 8003 Irvin St., Lancaster, Penna.

an immediate phone call to the man. Eight or nine of the next best will get telegrams to come see us at our expense. Of the remainder, some are good possibilities, and several are complete duds. As to the 'other engineering lures' like profit sharing, company cars, etc., mentioned in the article, we can go just so far. Engineers are employees of the company, no matter how hard they are to find."

The Engineers and Scientists of America, a national federation of collective bargaining groups of engineering and scientific employees has said, "Shortages, unfortunately, have been too often measured by the repetitive help-wanted ads in daily newspapers. Many, and perhaps most, of these ads are run upon order of a government contractor at government expense, by reimbursement. It would be enlightening to know how many applicants have responded to these ads, and the proportion hired."

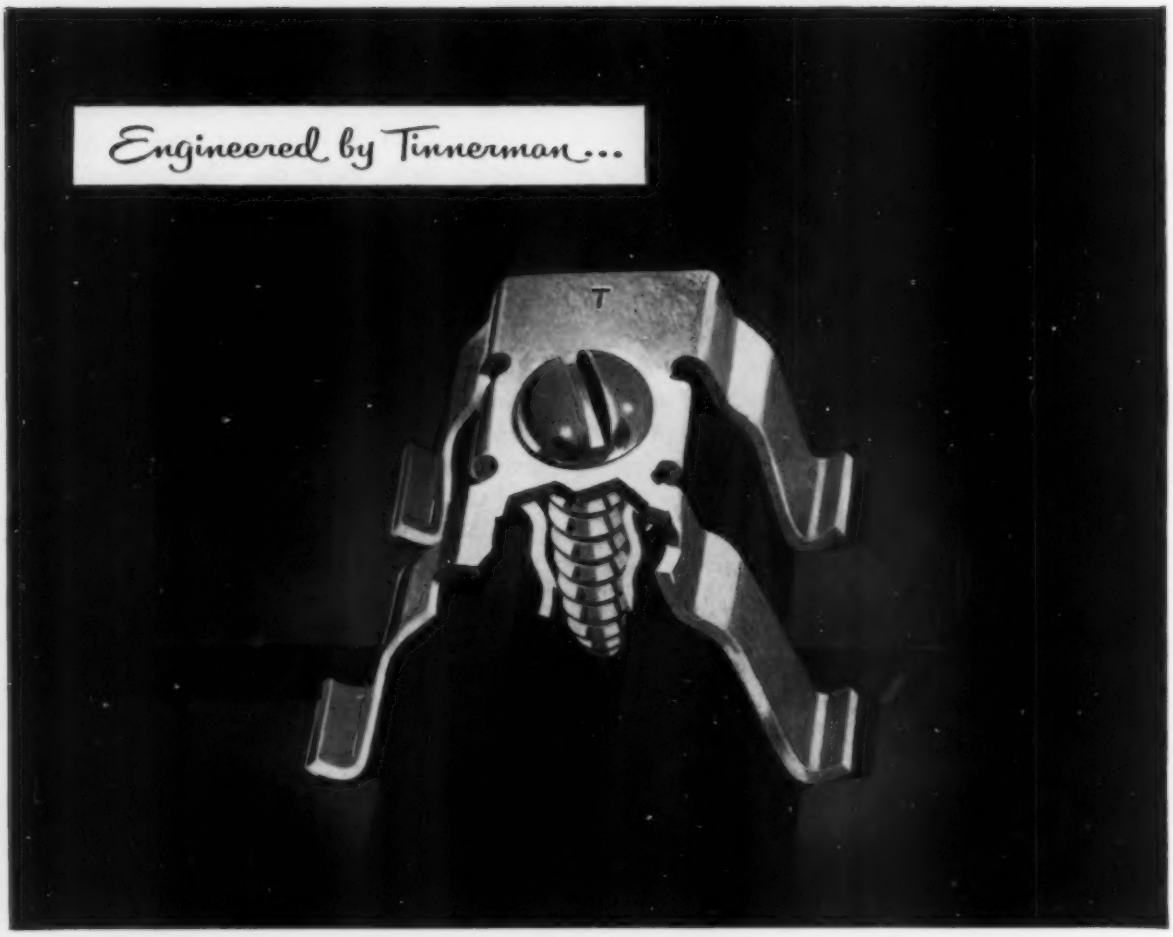
Just one year ago, Dr. Maynard M. Boring, Manager of Technical Personnel for General Electric Co., in Schenectady, N. Y., said, "Too much hysteria has surrounded the shortage of engineers in this country. If we had a 10 per cent drop in our defense expenditures, with the inevitable effect on our economy, we would have engineers raining out of our ears. If 68,000 engineers were provided for industry (the number represented as needed), industry would not know what to do with them."

SUCCESSFUL SEARCH IN GERMANY

Not limiting his search for engineers to the U. S., Dr. H. H. Woerdemann, president of the Magnetic Research Corp., Los Angeles, Calif., journeyed to Western Germany and returned with 10 electronic scientists and engineers for his company. But Dr. Woerdemann feels that he was fortunate, and that his case is the exception, not the rule. "American industry in general will find no solution to its own manpower shortages by looking in Europe. The lack of engineers in Germany is every bit as acute as it is here. Furthermore, existing conditions and restrictions make it close to impossible to undertake organized recruiting there. The German government looks with disfavor upon attempts of other nations to recruit technical people from German industry, and has recently issued restrictions against advertising for such personnel in that country's newspapers, if the place of employment is outside Germany.

"Still another complicating factor is that German engineers can quit their jobs only at quarterly periods during the year, and must give six weeks advance notice if they intend to leave their work. German engineers are, on the whole, content with their way of life in Germany. Salaries, working conditions, opportunity, and personal recognition are good, and prestige is high. They have the same professional opportunity there as well as here. European scientists and engineers also believe that their work is conducted on a much higher professional plane there than in the U. S."

Dr. Woerdemann said his personnel interviews were arranged in advance through an advertisement placed in a German technical publication, just before restrictions were imposed against such advertising. "The ad cost $35 and brought 35 replies, all from highly qualified people. This is in sharp contrast with U. S. recruitment advertising costs which often run several hundred dollars per hire," he said.



6-fingered **SPEED CLIP**®
holds glass panels tight, saves 46%!

This special SPEED CLIP fastens glass panels to aluminum extrusions with a grip that prevents slippage. Heat stays in, rain stays out of greenhouses and similar glass structures. Working closely with engineers of the Metropolitan Greenhouse Mfg. Corp., Brooklyn, Tinnerman developed this unique fastener that saves almost one-half the cost of former less effective assembly methods!

Installation is fast and simple. Two overlapping glass panels are positioned against the extrusion. A screw driven into the spring-steel SPEED CLIP spreads the two center fingers outward to grip the inner walls of the extrusion. No secondary fastening devices required—SPEED CLIPS hold tight, yet are easily removed to permit replacement of glass.

This is another example of a fastener engineered by Tinnerman to satisfy special, complicated fastening problems. A Fastening Analysis of your products may produce a similar cost-cutting solution. See your Tinnerman representative soon.

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FASTEST THING IN FASTENINGS®

(Canada: Dominion Fasteners, Limited, Hamilton, Ontario. Great Britain: Simmonds Aerocessories, Limited, Treforest, Wales. France: Simmonds, S. A., 3 rue Salomon de Rothschild, Suresnes (Seine). Germany: Hans Sickinger GmbH "MECANO", Langen-b-Hsn.

Are We Frankensteins?

Over a hundred years ago (1818), Mrs. Shelley wrote the tale of a young scientist named Frankenstein, who created a soulless monster. Failing to gain human sympathy, the monster eventually turned against his creator.

Are we scientists and engineers also creating a monster—our extremely complex mechanical civilization? The impact of rapidly accelerating technical advances has been tremendous. Many of these gains have been directly for the public good; many more, now military, show broader public potentials.

Expenditure for scientific research and development has risen from $166 million in 1930 to $5 billion plus in 1953—about 15-fold, allowing for the change in the value of the dollar. Scientists have increased from 46,000 to about 250,000 in the same period, engineers from 260,000 to more than 460,000. These increases, and current engineer shortages, indicate the value Industry places on our work.

But the danger signs are out that social development has not kept pace with science. The American Association for the Advancement of Science recently pointed out that "in some situations our enhanced ability to control nature has gone awry and threatens serious trouble." Examples are radiation from nuclear explosions; fumes, smog and dust from industrial, automotive and other combustion processes; depletion of natural resources; declining water table, poor flood control and urban crowding into flood plains; adoption of food additives, new drugs, and other man-made compounds without either long-term test or opportunity for study of effect, and the ultimate possibility of totally destructive war. Beyond all these physical danger signs is the psychological one—a civilization increasingly oriented toward material things.

In the language of the AAAS report, "the previously formidable gap between scientific knowledge and its application to practical problems has been considerably reduced. . .

"We are now in the midst of a new and unprecedented scientific revolution which promises to bring about profound changes in the condition of human life. The forces and processes now coming under human control are beginning to match in size and intensity those of nature itself, and our total environment is now subject to human influence. . . . In this situation, it becomes imperative to determine that these new powers shall be used for the maximum human good. . . ."

But who is to decide what is "human good?" It is obvious that we have more than one opinion in America, and the opinions of the rest of the world vary even more widely. There is evidence that one man's meat is still another's poison. The scientists propose that their organizations take more social responsibility, and that society ask and heed the advice of scientists. Any group of qualified engineers would make the same sort of suggestion.

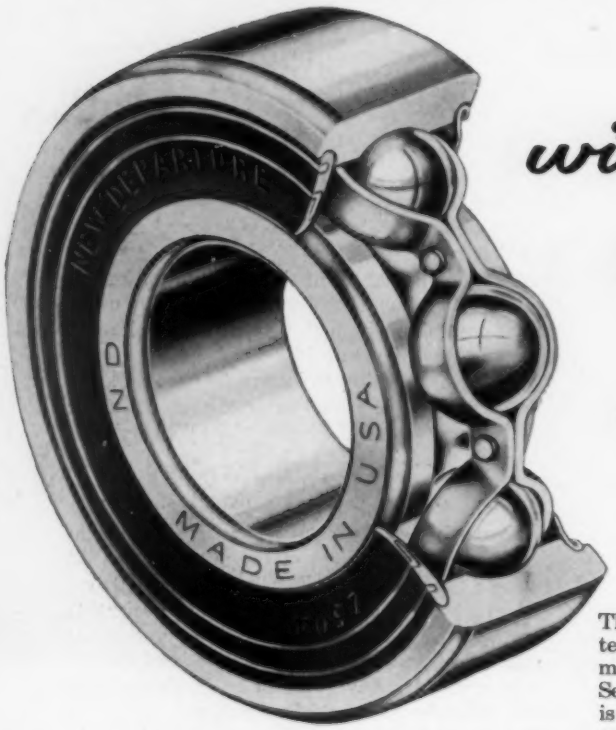
It is sound thinking for scientists and engineers to take social responsibility. Too often we are inclined to limit our thinking to a development and to disregard its possible social implications—if indeed we can recognize them. We, like Frankenstein, may create antisocial monsters. Perhaps we already have, because it is difficult for the creator of something new to view it without extreme bias.

We also have the right—and the duty—to advise society in general of the consequences of our developments, good and bad, as we see them. But we cannot expect society to heed our advice, any more than it might heed that of other individuals, groups or professions. In the field of our special competence, society *should* listen to our opinions; but in matters of public policy, our opinions are worth exactly as much, but no more, than those of other men.

FACTS

about

NEW DEPARTURE BALL BEARINGS



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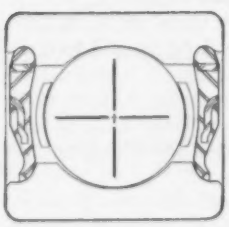

The diagram shows in section the New Departure Sentri-Seal. Lip-contacting surfaces are form-ground simultaneously with the ball race, giving an extremely high degree of concentricity between sealing surfaces and the raceway.

The unique design of the Sentri-Seal gives optimum protection against dirt, and includes a number of other major advantages.

Sentri-Seals can be removed, easily replaced. As the seal is of synthetic rubber in which two metal rings are embedded, a constant-rate spring is created between the rings. Inherent flexibility prevents distortion of the bearing outer ring due to seal insertion, permitting the use of bearings to the higher accuracy specifications. The spring action maintains an efficient sealing contact with the bearing ring to bar dirt and retain lubricant. Sentri-Seals are relatively inert to oils and greases and operate satisfactorily through a temperature range of −40°F. to 225°F. Specifications available for still higher temperatures. In applications where relubrication is desired, it is easily accomplished by the injection method.

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Sentri-Seal is available for a range of sizes in single-row, standard-width bearings and also in two types of New Departure adapter bearings. Sizes, dimensions and capacities are listed in the latest New Departure catalog.

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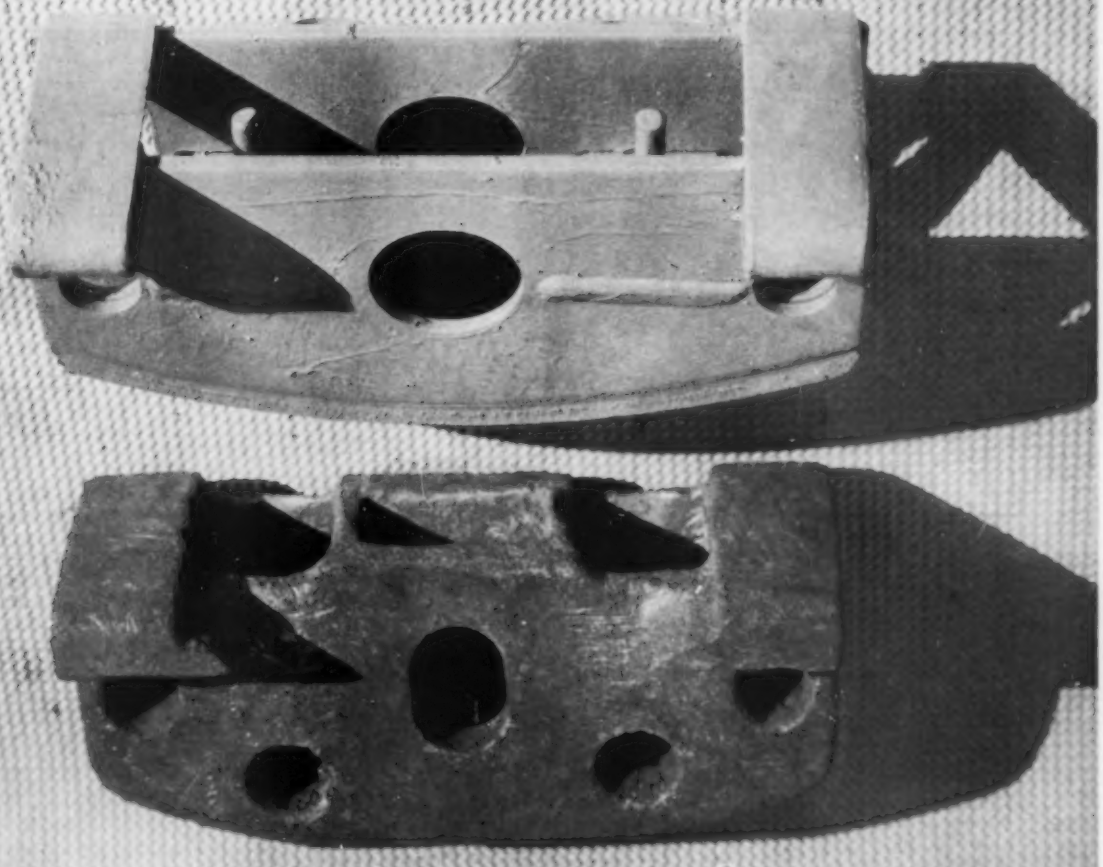


Redesigning CASTINGS to WELDMENTS

Factors influencing strength, rigidity, weight and cost of machine components produced by steel weldment. Analysis of vibration and noise problems.

OMER W. BLODGETT *Design Consultant*
The Lincoln Electric Company, Cleveland, Ohio

Common practice in redesigning from gray iron castings to mild steel weldments produces parts which are greatly overdesigned. As a consequence, such weldments tend to be uneconomical when produced in large quantities. Proper redesign should aim at producing a part which is the functional equivalent, not a physical copy, of the part it replaces. A weldment so designed can often shade the cost of the casting it replaces, regardless of the number of units involved.

Efficient redesign should be based on the physical and mechanical properties of the materials involved. The most important properties of gray iron and of mild steel are listed in Table I. When redesigning from castings to welded mild steel equivalent strength usually is required, or in some applications equivalent rigidity or stiffness. The amount of steel required to provide the same rigidity as obtained in cast iron is a function of the type of load imposed on the member:

For the same tension load steel requires only 40 per cent of the section area of gray iron. *(next page)*

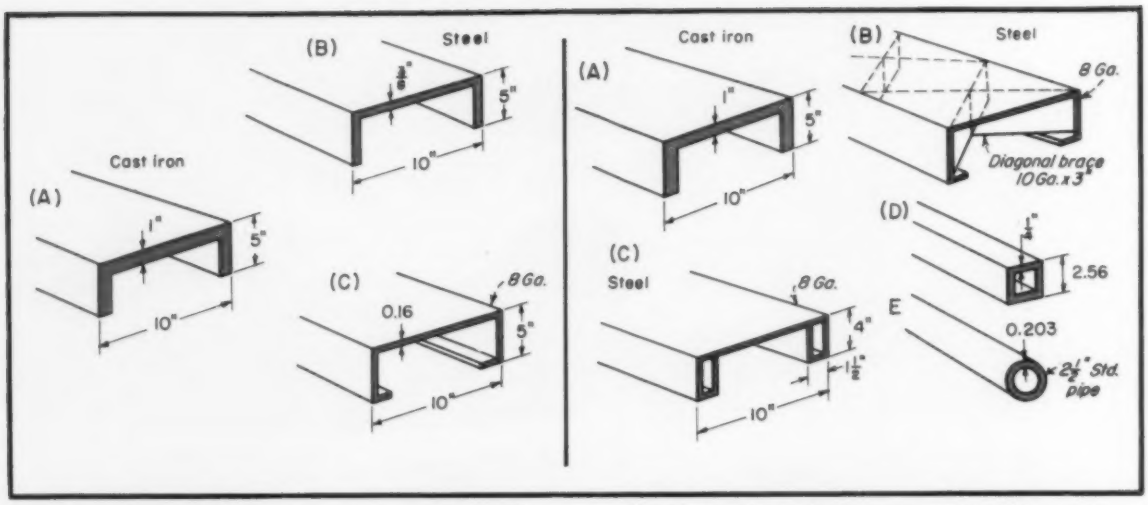


Fig. 1—A 1 in. thick gray iron member under bending stress (A) may be replaced by a $\frac{3}{8}$ in. thick steel weldment of the same shape (B) or by a 0.16 in. thick weldment of a slightly different shape (C).

Fig. 2—To resist torsional stresses, a 1 in. thick gray iron member (A) can be replaced by the design shown in (B) using 24 per cent as much steel. Other possibilities are (C) with 25.8 per cent, (D) with 12.8 per cent, or a $2\frac{1}{2}$ in. standard steel pipe (E) with only 9.4 as much steel.

TABLE I. PROPERTIES OF CAST IRON AND OF MILD STEEL

	Gray Iron	Mild Steel
Tensile Strength, psi	20,000	60,000
Compressive Strength, psi	80,000	60,000
Modulus of Elasticity		
Tension, psi	12,000,000	30,000,000
Shear, psi	4,800,000	12,000,000

For compressive loads a short column such as a pad under a motor would require almost as much steel as the original gray iron; for long columns, only 40 per cent of the moment of inertia of cast iron is needed in steel. As a result, a solid round cast-iron column may be replaced by a steel tube having only 22.5 per cent of the section.

In bending only 40 per cent of the moment of inertia of solid cast iron is required with steel. Fig. 1 shows how a gray iron casting can be replaced with a thinner steel weldment of the same shape, or with an even thinner one of a slightly different shape.

In torsion a gray iron casting can be replaced with a number of weldment designs, some of which are shown in Fig. 2.

Since many machines are made up of one or more of the basic types of members, the over-all weight of the replacing weldments should be approximately half the weight of castings. If higher than this, the weldment usually is too strong and rigid in comparison with the cast equivalent.

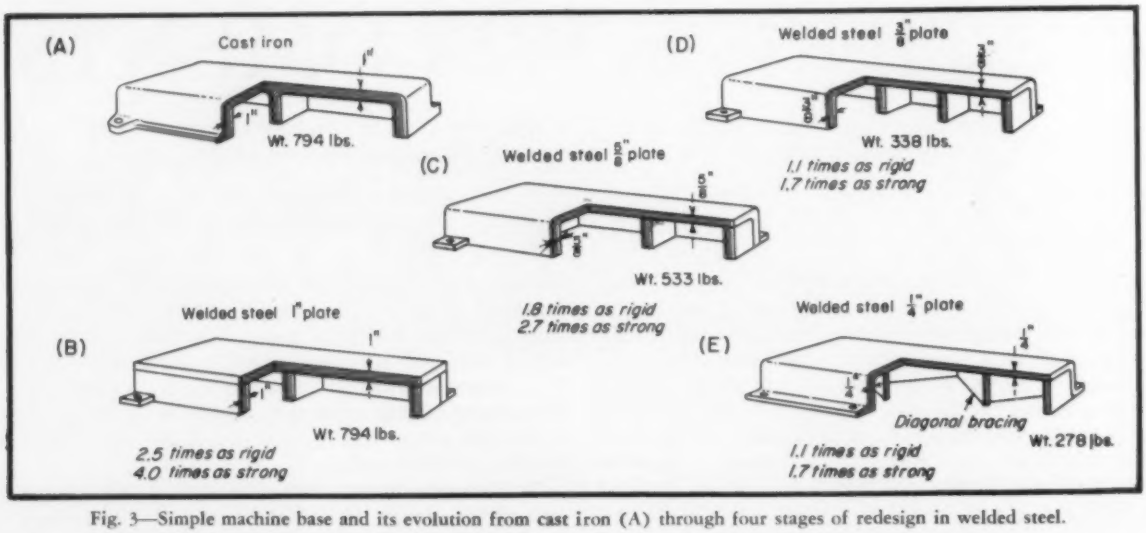


Fig. 3—Simple machine base and its evolution from cast iron (A) through four stages of redesign in welded steel.

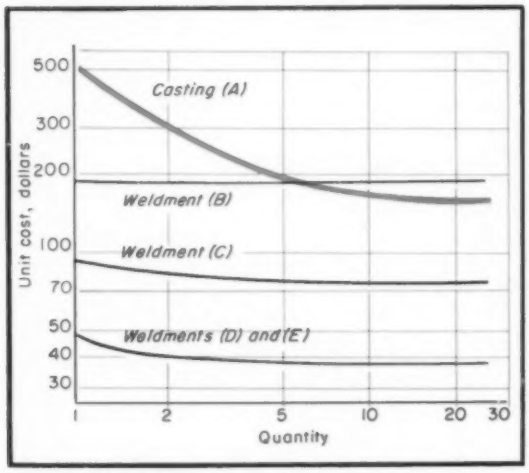


Fig. 4—Unit cost for each of the parts shown in Fig. 3 as affected by quantity.

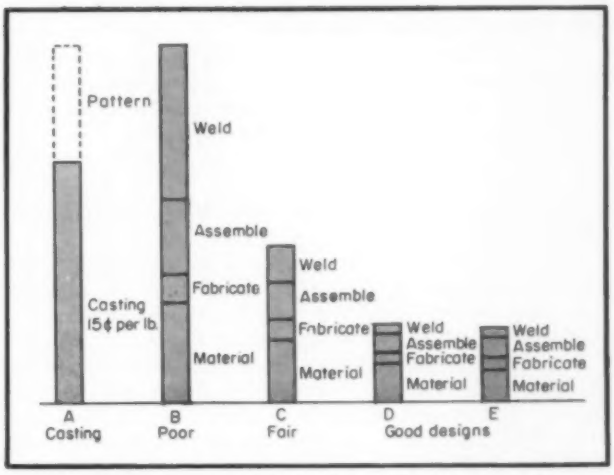


Fig. 5—Relative costs of the five bases in Fig. 3 in lots of five, broken down to show the elements comprising total cost.

A steel weldment starts out with a considerable material advantage over cast iron since the initial weight advantage is 2 to 1 and the cost advantage averages around 3 to 1. How much of this potential cost saving is retained in the final product depends on the choice of a design that can be fabricated at the lowest possible cost.

Economics of Design

A simple machine base as designed for cast iron and in four progressively more effective redesigns in welded steel is shown in Fig. 3. The casting is 1 in. thick, 60 in. long, 30 in. wide, and weighs 794 lb. On the basis of gray iron at $0.15 per lb, the cost is $119.10, exclusive of a pattern cost of $400. Unit cost, including pattern charges, is shown at (A) in Fig. 4 for quantities from 1 to 25 castings.

Referring to Fig. 3, to duplicate section thickness and weight in welded steel, as in (B) will result in a saving only for small quantities. The design is overweight and overwelded in regard to strength requirements. In this approach, the plates are beveled and welded approximately 100 per cent through the thickness, with welds continuous on both sides of the joints.

Second redesign in (C) using $\frac{5}{8}$ in. plate is more economical than (B) but still much stronger and more rigid than necessary.

Third redesign in (D) with $\frac{3}{8}$ in. sheared plate is formed in a press brake and then welded. Note how weight and cost are decreased with no sacrifice of rigidity or strength.

Final redesign in (E) uses $\frac{1}{4}$ in. plate with a flanged base to provide rigidity. In addition, internal diagonal bracing is added to increase torsional stiffness. This design saves about $\frac{3}{4}$ of the cost of the casting and weighs only 35 per cent as much. If pattern charges are included in the casting cost, unit cost of a weldment for a total production of 20 is actually only 24 percent of the casting cost. As shown in Fig. 4, steel bases (C), (D) and (E) are well under the cost of a casting for any quantity.

The effect of the design on relative cost of material, fabricating, assembling and welding operations is shown in Fig. 5 for an assumed quantity of 5 parts. Note that cost savings over the original casting are appreciable for all designs except the inefficient design (B).

Using the same examples, the relation between cost, strength and stiffness is shown in Fig. 6 on the basis of comparative weight. When the relative weight is brought under 75 per cent of the casting the cost starts to favor welding. When the weldment is brought down to 50 per cent of the casting weight, the strength and stiffness are both still higher than for the casting.

As a general rule, the ratio of the weight of weldment to the weight of casting it replaces is a good indication of efficiency in weldment design. Assuming a minimum cost weldment designed to be the functional replacement

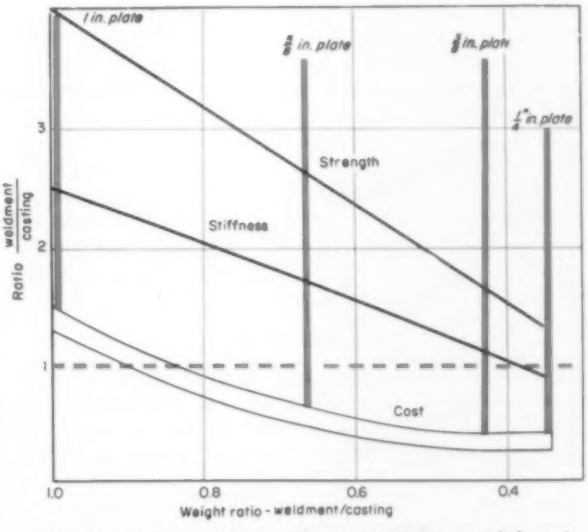


Fig. 6—Strength, stiffness and cost of the four welded steel bases compared with a cast iron index of 100 per cent.

of a casting, the nomogram in Fig. 7 will give the approximate cost of weldment fabrication.

Forming operations can often be reduced by using standard shapes such as channels, angles, I-beams, H-beams, T and Z sections and tubular elements as well as the conventional flat rolled and bar sections.

Welding Rules

These eight elementary rules of welding procedure should be observed:

1. Do not overweld. Best practice is to keep welding cost at a maximum of 50 per cent of total labor cost.
2. Base the weld bead size upon the thinner of two plates being joined as shown at (A) in Fig. 8.
3. Where full-strength welds are required, the throat of a butt weld must equal the plate thickness, and the leg size of fillet welds should be $\frac{3}{4}$ of the plate thickness as in (B). This assumes welds are the full length of the plate, and fillet welds are on both sides of the plate.
4. In designing for rigidity, use 50 per cent of full-strength welds—for example, half the length or half the weld size as shown at (C).
5. For secondary members, such as stiffeners and bracing, use less welding than for rigidity designs.
6. Use as high a welding current and electrode size as are practical.
7. Position work for flat or downhand welding.
8. Determine the possibilities of automatic or semi-automatic submerged arc welding.

The following guideposts may be applied to check a welded steel redesign of a gray iron casting:

Weight of steel weldment should be about 50 to 60 per cent of a gray iron casting for equal strength and rigidity.

Material cost should be 5 to 25 per cent of the casting cost.

Labor cost of welded steel design should be about 30 per cent of the casting cost.

Welding cost should be 20 to 50 per cent of the overall labor of the steel design.

An example of redesign for lower weight and cost is shown by the double-acting spring bumper for mine cars in the headpiece picture. Originally cast from 1.5 per cent nickel iron, it weighed 135 lb, even with the lightening effect of cored holes. Frequent service failures from impact led to the redesign in welded steel, weighing only 50 lb. Since production lots ran to 200 or more, setting up on a bench fixture made it possible to assemble and tack weld the 13 component parts, then finish weld by semi-automatic, submerged arc process, all in only 48 min per piece. Elements are sheared, punched and formed from $\frac{3}{8}$, $\frac{5}{8}$ and $\frac{1}{4}$ in. plate. The size is roughly 18 in. wide, 8 in. deep and 9 in. from front to back.

Vibration Control

In addition to rigidity and strength, machines often require freedom from vibration, both self-induced and transmitted. This is especially true in machine tool bases and components since the general acceptance of carbide and other ceramic tools has called for increased speeds and feeds.

Vibration cannot be eliminated: it can be absorbed or controlled. Cast iron tends to absorb it because of its high damping characteristics. Steel has substantially less damping capacity, therefore a redesign to weldment must eliminate resonant vibration through design. This need not involve long calculations. A working model can be made and tested in operation: if chatter or other undesirable vibration is experienced, the vibration characteristics of the member can be changed.

In coping with vibration problems, the following considerations are important:

1. Steel is $2\frac{1}{2}$ times as rigid as gray iron and, as a result, it deflects only 40 percent as much for the same force and cross section.
2. Steel has a natural frequency of vibration 58 per cent higher than gray iron, so that a machine built of steel has a 58 per cent greater range of operation before an undesirable resonant frequency is reached.
3. With welded steel construction, modifications such as additional ribs and stiffeners can be introduced if necessary after a machine has been completed and tested. Unsupported lengths of vibrating members can be shortened to reduce the amplitude of vibration and at the same time increase the safe frequency range.

Effect of Weight on Vibration

Normally, the overall dimensions of a machine component must remain unchanged in any redesign. If the weight is to be reduced, this is usually accomplished by use of thinner sections. In general, if the shape and outer dimensions remain unchanged the moment of inertia of a section will vary with the thickness, and therefore with the weight of the section. A reduction in weight produces a corresponding reduction in moment of inertia. This reduces flexural rigidity (modulus of elasticity multiplied by moment of inertia), and increases the deflection or amplitude of vibration. Thus, a lighter member will have a greater amplitude of vibration as a result of reduction in moment of inertia. A change from a heavy cast iron piece to a lighter steel section may give a reduction in amplitude of vibration if the increase in elastic modulus offsets the decrease in moment of inertia caused by the lighter section.

Noise Can Be Silenced

In lighter sections, redesigned members often become rather thin, giving rise to concern over noise in operation. Noise occurs when the natural frequency of a part lies in the audible frequency range, its pitch depending upon the frequency of vibration and its volume upon the amplitude.

Two common methods to circumvent a noise problem are:

1. Break up the vibrating member or panel into shorter units, reducing the unsupported length of the panel. This can be done with stiffeners, or by ribbing, flanging, bending or embossing the panel, thus increasing the frequency to a point well above the audible range. Small stiffeners may be tack welded to steel sections for added rigidity and to increase the natural frequency. When placed at a 45 deg angle, they become diagonal braces and provide added resistance to twist.
2. Damp possible vibration by the application of any one of a number of good muffle coatings to the inside surface of the panel. Cementing various types of fiber

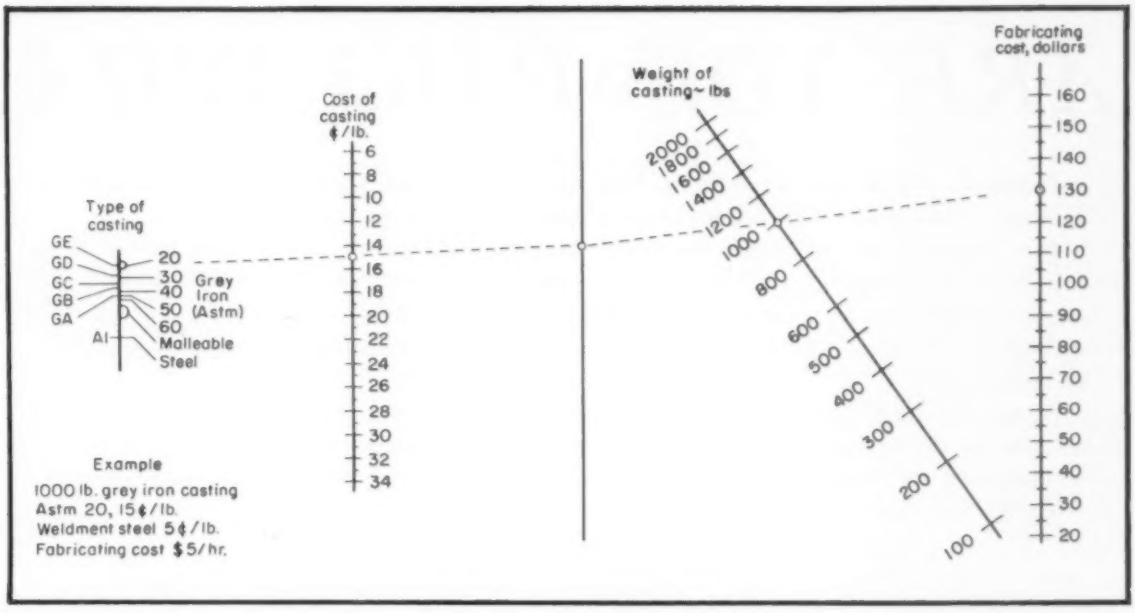


Fig. 7—Quick method for determining fabricating cost for a weldment designed as the functional equal of an iron casting.

or insulating materials to the panel is another alternative.

In the case of torsional vibration, increasing the torsional resistance of a member will increase its natural frequency and also reduce the angle of vibration. This can be accomplished by the use of either closed box sections or diagonal bracing.

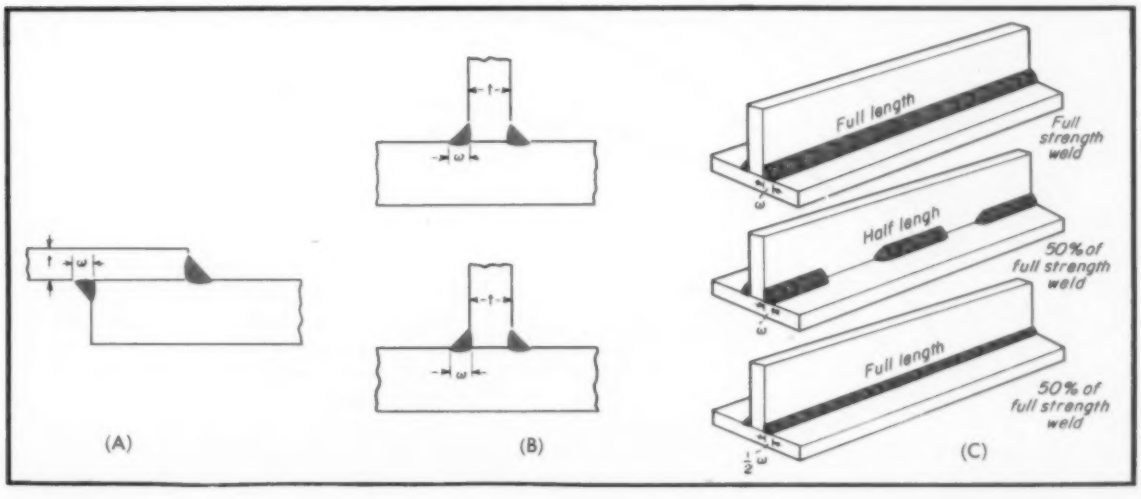
EDITOR'S NOTE: A chart indicating which welding process should be chosen on the basis of materials to be welded and on joint design appeared in the 5th Product Design Digest issue, page D6.

Earlier articles on specific welding processes include: "Spot Welding From One Side with a Portable Gun," April 1955 page 180, which discussed factors affecting quality of welds produced by the inert-gas shielded tungsten-arc process. "A Progress Report on Shielded Tungsten-Arc Welding," February 1954 page 170, covered applications of the process in seam-welding of stainless steel and other metals.

Damping characteristics of structural materials have been discussed in two recent articles. "Damping Capacity of Materials," November 1954 page 164, offers a practical approach for evaluating damping and present specific data on a variety of materials. "Manganese Copper High-Damping Alloys," May 1956 page 135, includes mechanical properties and potential applications of several alloys combining high tensile strength and high damping characteristics.

"The Weldability of High-Tensile Structural Steels," published by the British Welding Research Association, was reported on in August 1956 page 185 under the title "Cracking of Welded Low-Alloy Steels."

Fig. 8—Some basic welding rules. (A) Make bead width equal to thickness of thinner plate. (B) Bead width should be $\frac{1}{4}$ of plate thickness. (C) Design for rigidity requires only 50 per cent of full strength welds.



ARE YOU PAID WHAT

Engineer's salaries have not kept up with national productivity and wages. This condition is largely attributed to the attitudes towards salaries that prevailed up to about 1952.

It is proposed that salary administration recognize and take account of three independent factors. First, the secular (industry) trend or general increase that is granted to all without regard to individual experience or merit. Second, experience, which must be taken into account throughout the whole career. Third, a merit differential that has real incentive value should be reestablished.

A pattern for pricing different degrees of experience and merit is proposed. It is reduced to a formula that establishes a salary policy, and provides flexibility for changes caused by the secular trend. *A condensation of a report presented at the Engineers Joint Council General Assembly, January 17, 1957.*

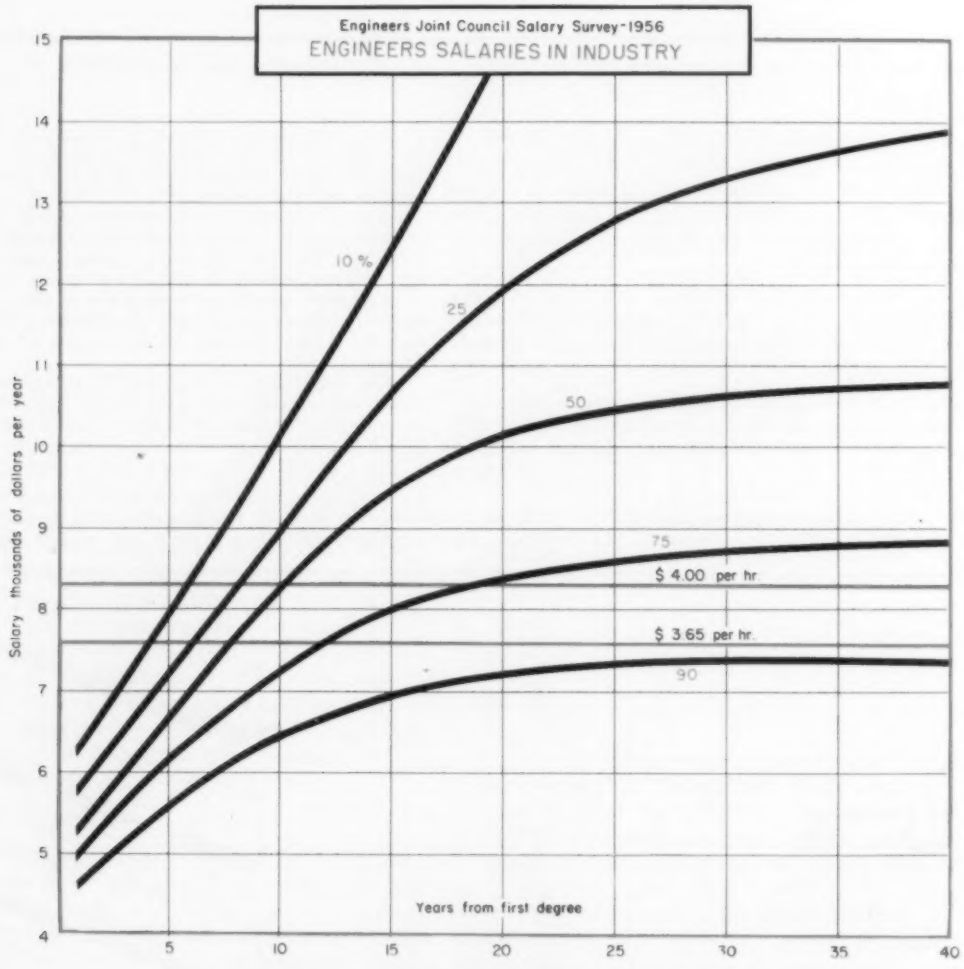


Fig. 1—Percentile salaries of engineers in industry as they vary with experience (YFD). The top line represents the minimum salary of the top 10 per cent of engineers. Lower lines have equivalent significance for other percentiles.

YOU'RE WORTH?

DR. EDWARD B. PECK

Formery Consultant to Esso Research and Engineering Co.
Now Adjunct Professor at Rutgers College of Engineering.

There is much talk about incentives other than pay, and they are important. But the hub of the incentives that industry can offer is pay. When pay is not about right, the other incentives have a hollow ring.

Many articles on this subject emphasize "telescoping salaries": salaries do not grow with experience as much as they used to. Most of the upper middle class has been squeezed by the social and economic leveling in our economy. Productivity and wages have been rising rapidly while top salaries have, until quite recently, remained static.

ENGINEERS' SALARIES–1956

The 1956 Salary Survey of the Engineers Joint Council, for engineers employed in industry, is summarized graphically in Fig. 1. Experience is measured in years from first or bachelor's degree (YFD). The percentile curves mark out merit levels. Any engineer can spot his 1956 salary on this graph and know what percentile his salary falls in, and he can relate this position to an evaluation of his performance and potential. Of course there are a lot of correction factors to be applied. All industries do not pay equally well. Chemical engineers are paid better than civil and sanitary engineers. Research and development pays better than production engineering. Industry pays better than government and education. For this last reason, Fig. 1 presents engineers' salaries in industry.

The horizontal lines at $8,300 and $7,600 represent craftsmen's pay. It is considered appropriate to compare engineers' salaries with craftsmen's wages because they are alternate careers for young men capable of becoming engineers. These are rates in the New York area for building trades. They are $4.00 and $3.65 an hour for one year at full time and without overtime. Certain highly skilled crafts in industry are paid this much or more, but the statistics are obscured in average hourly rates of industy.

The median (50 per cent) salary curve for engineers intersects the craftsmen's wages at 7.5 and 10 years of experience. This means that the average engineer is 30 years old before he catches up in pay with the carpenter and electrician, and it takes two and a half more years to catch up with the plumbers and bricklayers. When the pay represented here is integrated over a career of 43 years (age 22 to 65), the median salary of engineers exceeds that of the carpenters by about $80,000 and of the plumbers by less than $50,000. This is not an attractive return on the investment for an engineering education.

THE TREND IN SALARIES 1939-1956

The period 1939-1956 has been one of great economic expansion. The gross national product measured in current dollars increased more than four-fold, while the cost-of-living index about doubled. Wage rates increased about three-fold while top management salaries increased even less than the cost of living. Almost all middle-class salaries were squeezed between rising wages from below and a relatively static top management salary.

These data are presented in Table I along with engineers' salaries for the years 1939, 1946, 1952 and 1956. Note that engineers' median salaries increased 250 per cent for beginners, but declined with experience to 65 per cent. The older engineers' pay did not keep up with the cost-of-living index which increased 97 per cent.

When this period is divided into three parts, 1939-1946, 1946-1952 and 1952-1956, the relationships are different. The differences can be related to attitudes typical of those periods. The first period, 1939-1946, is the only

TABLE I—ECONOMIC TRENDS: 1939-1956

Year	Consumer Index	Gross National Product	Work Force	Productivity	Weekly Payroll in Engineering
1939	59.4	91.1	45.7	2000	29.9
1946	83.4	209.2	55.2	3780	81.2
1952	113.5	345.4	61.1	5650	136.6
1956	117.1	407.0	63.0	6450	158.3

Wages and Engineers Salaries

Year	Average Weekly Wages in Mfg. $/hr.	Experience Level (YFD) $/month			
		0–1 Year	9–11 Years	20–24 Years	35–39 Years
1939	0.633	127	259	435	550
1946	1.086	232	401	515	629
1952	1.670	356	549	670	670
1956	1.950	443	670	852	905

Percentage Increase for Significant Periods

	1939–46	1946–52	1952–56	1939–56
Productivity	89	50	14	223
Consumer Index	41	36	3	97
Median Engineers' Pay at Experience of:				
0–1 year	83	54	24	250
9–11 years	55	37	22	159
20–24 years	18	30	26	91
35–39 years	14	7	35	65
Wages	72	54	17	208

one where productivity increased faster than average hourly wage rates. In 1939 unemployment was high compared with subsequent years. This suppresses productivity more than in direct proportion to the unemployment. In the next period, productivity, wages and engineers' salaries increased the same amount. The higher-paid and more experienced engineers, however, did not gain so much in pay. In the last period, the cost of living increased very little, and productivity increased less than the wage rate. Engineers' median pay increased faster than any of them and at all experience levels, for the older engineers most of all. Even with this last spurt the experience increment along the median is only half as much in 1956 as it was in 1939.

The merit incentive dropped at mid-career (20-24 YFD) from 233 per cent in 1939 to 92 per cent in 1956. This is measured as the difference between the 90th and 10th percentile salaries at 22 YFD as shown in Table II.

The incentive that Civil Service offers for higher competence is governed by job classifications and corresponding salary ranges. They were adjusted in 1945 and in 1955,

TABLE II—ENGINEERS' SALARIES: TREND IN MERIT SPREAD
Percentage Difference in Percentile Salaries at 20–24 Years Experience Level

Year	50th to 10th	75th to 25th	90th to 10th
1939	96	86	233
1946	80	59	169
1952	..	48	..
1956	50	49	92

TABLE III—TREND IN CIVIL SERVICE SALARY RANGES

Classification	Minimum Salary of Classification		Percentage Increase 1945–55
	1945	1955	
S.P. 1	$1,440	$2,690	87
2	1,572	2,990	90
C.A. F. 4	2,100	3,415	63
8	3,310	4,970	50
12	5,180	7,570	46
15	8,750	11,610	33

with substantial telescoping. The lowest classification increased about as did labor—87 per cent as shown in Table III, while the highest classification increased only 33 per cent. One wonders how much the Civil Service, in holding down salaries in the higher-classified jobs, yielded in qualifications and performance of personnel.

It is interesting to see what engineers' salaries would be in 1956 if those in the 1939 survey had been increased by the same factor as wages. Starting salaries would be lower than they are now (Table IV). The median would rise to $16,000 per year at mid-career compared to about $10,000 now. The median would end at about $20,000 compared to $11,000 now. The bottom decile would end at over $11,000, and the top 10 percentile at mid-career would be $30,000, compared to $15,000 now.

TABLE IV—ENGINEERS' SALARIES RELATED TO WAGE INCREASE (1939-1956)
(Factor 1.95/0.63 = 3.08)

Years of Experience (YFD)	Upper Decile (10%)		Median (50%)		Lower Decile (90%)	
	1939	1956	1939	1956	1939	1956
0	178	550	127	391	....	....
20–24	850	2620	435	1340	255	785
35–39	....	....	550	1694	290	894

It seems appropriate to suggest that engineers' salaries should have risen by the same percentage as wages until one realizes what that would do to the other relationships.

The compensation for the entire upper middle class has been contrasted with engineers' salaries. When taxes and other things are considered, the higher the salary, the more it has lost ground with respect to labor. It is a complicated matter to adjust engineers' salaries so that merit and experience incentives are reestablished. Some industrial organizations have adopted the principle of raising all salaries by the same percentage as wages (a few have done this substantially all the time, at least up to a higher figure than shown in the survey). Civil Service has not, and there are degrees of differences in between.

The economic outlook is for a secular growth of about 3 per cent per year. This is based largely on past experience and confidence that technology and good management can, and will, be willing to provide it. Wages are expected to go up at least as fast because labor's cooperation and buying power are also needed. This means that wages will at least double in less than 25 years. Engineering salaries should keep up.

One alarming feature of granting such national trend increases is that they will exceed the merit and promotional raises of the average engineer. The difference between the ends of the median salary curve of the current survey ($5,300 to $11,000 per year) is 24 raises of 3 per cent each. In the same time the average engineer would get 40-odd raises for the secular trend. It is quite possible that our economic progress will run down, for the lack of sufficient incentives to develop the essential technology.

A PATTERN FOR SALARY ADMINISTRATION

A variety of plans have been developed for using a salary survey as a guide in salary administration. They have met with varying degrees of success. At best, they supplement good job evaluation and merit rating. The following analysis is based on a plan that has been moderately successful for ten years.

The survey shown in Fig. 1 shows salaries at a particular time. And it shows relationships for merit and experience at that time. When a general salary adjustment occurs, as with wages, and without regard to merit or experience, the survey and salary chart are obsolete. A new one must be made. It is therefore desirable to have a formula for making each succeeding chart.

The curves are guides for distributing merit and promotional raises over a career. They are much clearer than some of the traditional guides. Furthermore, when the curves are expressed as mathematical equations, they

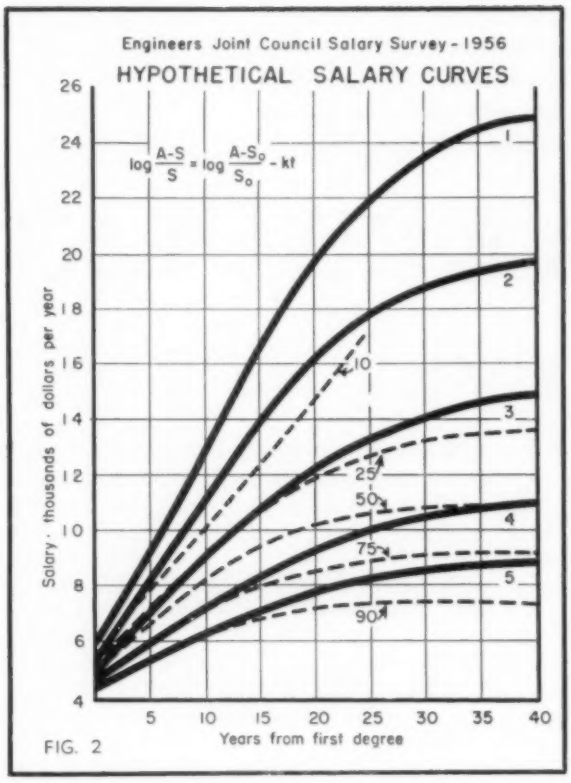


FIG. 2

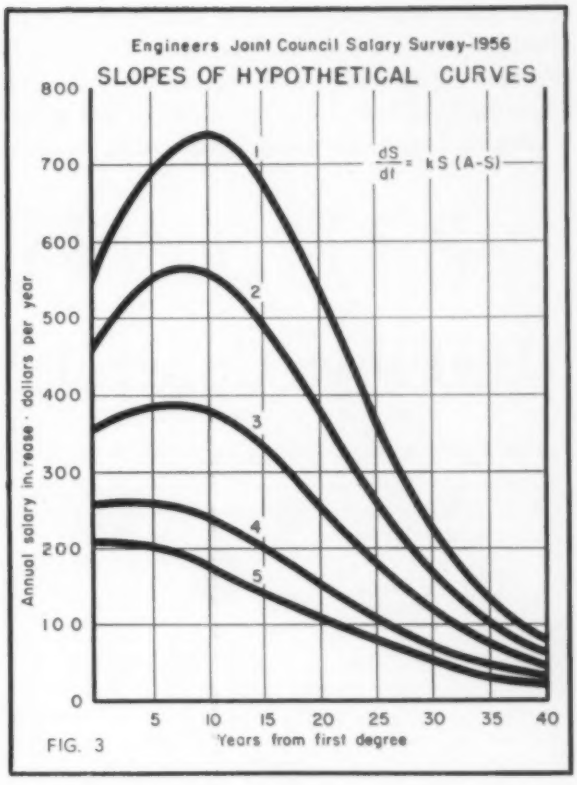


FIG. 3

can be translated into clear statements of policy. The obvious guides, without the curves are: first, the median curve running from $5,300 to $11,000 a year provides 40 annual incentives of $12 per month. A duller tool is the percentage increase. Some salary administrators do not think it is proper to give raises of less than 5 per cent of salary. Along the same median curve, there are only 15 raises of 5 per cent and only two of these are available in the last 20 years of a man's career. Along the 10th percentile curve, there are 21 raises of 5 per cent in 21 years.

It is also necessary to develop a rational and equitable system for all levels of merit. The only curve in the survey that suggests a regular annual percentage increase in salary with experience is the top 10th percentile curve. The other curves flatten out with increased experience. Does this represent a different salary policy for all but the top 10 per cent? This query can be objectively answered when all these curves are represented by a single equation. Analysis of earlier surveys together with an analysis of annual merit and promotional increases as a function of experience, showed that several equations could be used. The one selected, when translated into words, offers a simple and equitable statement for salary policy. At the same time it presents a sound formula for budget control.

The equation says that at any merit level, the annual rate of salary increase is proportional to the salary, multiplied by the amount of money left for salary increases for the rest of the career. This is how the potential idea got into salary administration. These salary curves suggest that each curve is aimed at a goal which is a potential for the employee. This potential had been, perhaps, an unconscious factor in salary administration. This does not mean that an employee is tagged with a potential early in his career and has to live with it. Periodic merit ratings and performance reviews change these potentials.

The mathematics of this statement is:

$$dS/dt = k\,S(A - S)$$

Where S is the salary, t is the experience, or YFD in years, k is a constant computed for each curve from the end conditions, A is the potential salary or asymptote of each curve. The value A in relation to the final salary at 40 YFD determines the distribution of raises between the first and second half of the career. Experience shows that when A is 3 per cent above the final salary at 40 YFD, there is a good distribution.

The equation is integrated to:

$$log\left(\frac{A-S}{S}\right) = log\left(\frac{A-S_o}{S_o}\right) - kt$$

A set of curves has been calculated as presented in Fig. 2, running from the starting salaries in the survey to $25,000, $20,000, $15,000, $11,000 and $9,000 respectively at 40 YFD. In practice the curves might run from starting salaries to the maximum salaries of job classifications. This allows for a definition of potential.

The slopes of these curves which show the annual salary increase are plotted in Fig. 3. It is interesting to note that these slopes rise to maxima fairly early in the career. In this sense they conform to the productivity curves for outstanding intellectual people as shown in Lehman's book "Age and Creativity."

First and second installments in this series of articles covering Relief Valves and Pressure Control Valves appeared in December 1956 and January 1957 issues of *Product Engineering*. Two further articles to be published in early issues will describe directional valve spool design and application, and later some special hydraulic circuits including regenerative, tandem and high-low configurations.

HYDRAULIC

III. Flow Control Valves

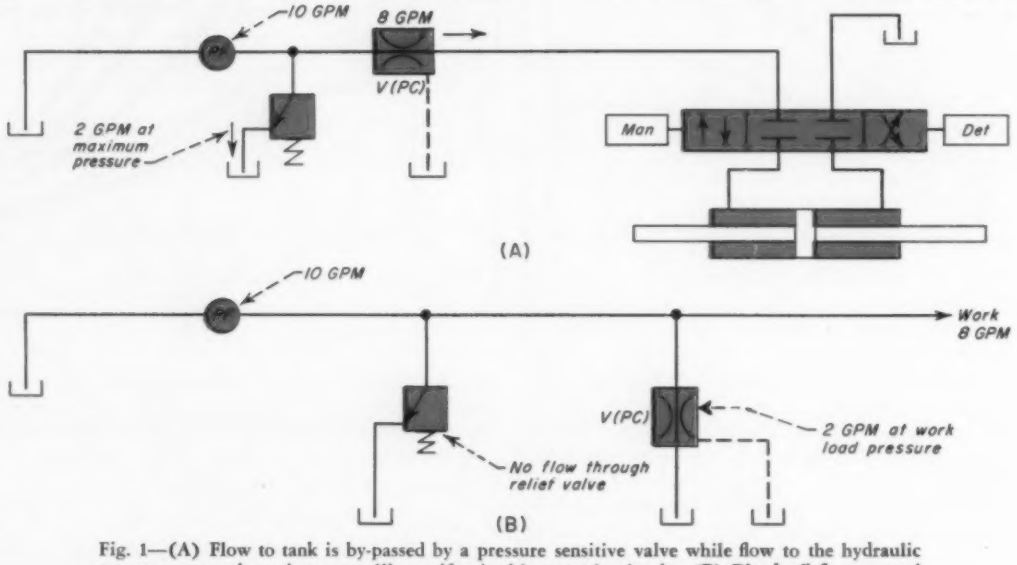


Fig. 1—(A) Flow to tank is by-passed by a pressure sensitive valve while flow to the hydraulic actuator passes through a controlling orifice in this meter-in circuit. (B) Bleed off flow control conducts bypass oil through the orifice to achieve flow control at the hydraulic actuator.

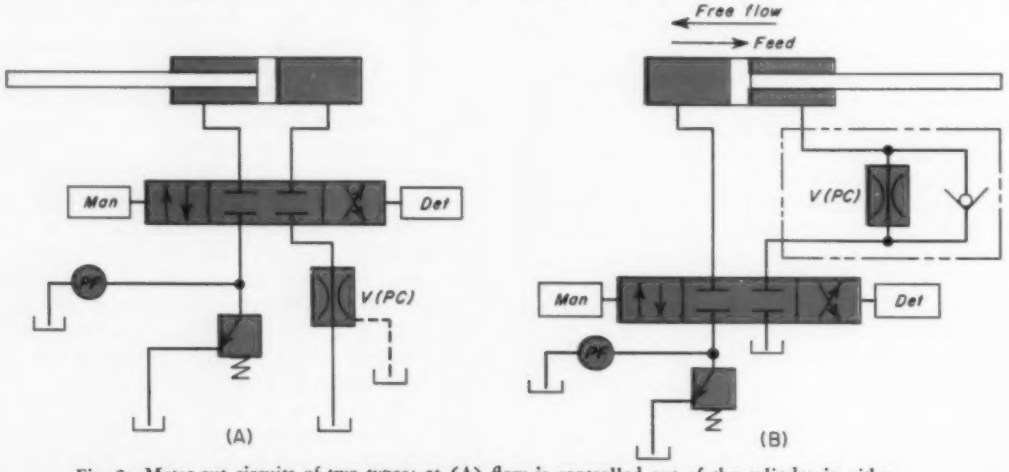


Fig. 2—Meter-out circuits of two types: at (A) flow is controlled out of the cylinder in either direction. At (B) the feed is controlled but a check valve permits free flow return.

JOHN J. PIPPENGER
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CONTROL VALVES

These valves control and limit flow to, therefore speed of, a hydraulic actuator. Included are details of construction, operation and maintenance of direct and pilot operated flow control and check valves.

MANY advances in the art of metal working can be traced to the fine feeds made available by hydraulic transmission of power. Variable displacement pumps are excellent for this type of service but they may be too expensive to warrant installation in some circuits. Flow from a constant delivery pump may be controlled by an orifice effectively and at reasonable cost. This orifice may bypass part of the pump output to tank or it may be used directly in the line with an alternate flow path to tank provided by an additional valve. Fig. 1 shows two examples of these circuits.

The basic problem with orifices is that flow is a function of pressure drop as well as area. When pressures at the cylinder or fluid motor fluctuate in response to load changes, flow rate is affected. Some additional pressure-sensitive device must be used to compensate.

Simplest form of compensator is a reducing valve installed between high pressure line and the orifice diverting fluid to tank. Control of orifice area and the secondary pressure of the reducing valve insures a fixed flow of bypass oil. Total pump delivery minus bypass flow determines flow to the cylinder or fluid motor. Work load determines maximum pressure.

Combined orifices and reducing valves are available and widely used when large volumes of fluid are involved as in broaching machines, large planers and shapers.

A variation on this circuit makes use of a needle valve as a combination flow control and relief valve as shown in Fig 1(B). Various types of die tryout presses, leather molding presses, and certain types of straightening presses, as well as laboratory presses incorporate this circuit which is simple and satisfactory. The pressure generating device is protected with a relief valve set at maximum operating pressure. The whole circuit consists of a pump, relief valve used as a safety device, operating ram, large needle valve bypassing oil to tank, and piping.

The pump delivers oil whose minimum pressure is a function of the resistance of the needle valve when wide open. As the needle valve is closed resistance to flow increases, and pressure rises to a point at which the ram will start to move. At this point the needle valve is a combination relief and flow control valve. As the orifice through the needle valve is further decreased, ram movement speeds up. When the ram meets heavier resistances pressure develops according to the size of orifice at the needle valve. Ram speed drops since more fluid is diverted through the orifice. When the needle valve is completely closed pressure will rise to that value set on the maximum pressure relief valve. A check valve may be installed in the line between pump and ram to hold the oil in the ram with pump not operating.

Meter-out Circuits

When more precise control is required two basic methods are used. Oil may be metered directly into or out of the cylinder. The meter-in circuit is generally used as shown at (A) in Fig. 1, when the valve controls rate of flow to a directional valve so that speed will be uniform in both directions (assuming a double end rod cylinder or motor) or when back pressure on the directional control valve would impair circuit function.

The meter-out circuits shown in Fig. 2 are most widely used in milling, drilling, reaming, and spot facing circuits. Their basic advantage is that they act as a check on the tool. When climb milling and drilling there is a tendency for the cutting tool to pull through the work at some points. The meter-out circuit prevents this action. The meter-out circuit also takes up all hydraulic play by keeping a back pressure on the piston at all times.

An adequate supply of control oil is vital for proper operation of a flow control circuit. A minimum of 4 or 5 cu in./min is specified on many flow control devices. This is an absolute minimum based on clearance flow requirements of the valve components. As such, it should be like a red flag to the circuit and machine designer. Recognizing that wear is difficult to estimate on hydraulic equipment, hard and fast rules cannot be made as to how much consideration should be given for normal wear. For new components 5 cu in./min may be sufficient; a minimum of 25 cu in./min is reasonably conservative when wear is taken into account.

Many circuits do not operate anywhere near this low a flow, and it is not a problem. In other installations the force required is low and small cylinders seem adequate and desirable. Valves are then asked to function on flows that could not be controlled by the finest needle valve.

Other components in the circuit must be taken into consideration; such as, the clearance flow past rings on a cylinder, any spool type valves in the circuit, or other packings which may drain oil out of the control circuit. Most control panels are based on a meter-out circuit. If the oil

is clear and components kept in good order, wear factors are insignificant. However, foreign matter in the fluid medium can cause rapid wear. Over a period of time the clearance flow may increase from 5 to 10 cu in./min. If the feed is based on a rate between 5 and 10 cu in./min, this wear is critical. If the feed were based on flows of 20 or 25 cu in./min, the wear would do no harm.

Of course economics fit into this picture and cylinders of adequate size often offer space problems. However, good engineering practice dictates the requirement for adequate control oil. Larger cylinders will operate satisfactorily at lower pressures and circuits can be designed so that lower pressures decrease clearance flows so the advantages pyramid.

FLOW CONTROL VALVES

Flow control valves fall into several basic categories. For machine feeds with varying pressures and loads, a compensated flow control mechanism is usually required for satisfactory operation. Machine feeds with relatively constant loads and pressures may operate satisfactorily with a precise, adjustable-orifice flow control valve without any compensating mechanism. Certain other mechanical movements controlled and actuated by fluid power may also operate satisfactorily with a rather coarse adjustable orifice without integral pressure compensation ahead of the orifice to control the flow of fluid.

Non-Compensated Flow Control

Simplest form of flow control valve is basically a check valve poppet held off the seat by a mechanical screw jack adjustment as shown in Fig. 3. The adjustment is sealed from pressure so that the valve does not leak when adjusted. Reverse flow to the under side of the poppet lifts it and passes through the valve in free flow. Flow in the opposite direction closes the poppet against the screw jack so that the resultant orifice determines the flow rate through the valve. A relatively low number of turns of the screw jack will alter the flow from a stopped position to wide open. The valve poppet can be lapped to the seat if it is desired to use the valve as a high pressure globe valve with a free flow check in one direction.

Another group of flow control valves performs a similar operation but in a more precise manner as shown in Fig. 4. The adjustment requires many more turns of the adjusting screw from full open to full closed. This relatively fine adjustment is further improved by using a sliding fit spool rather than a seated poppet. Minimum flow is controlled by the physical clearances between spool and valve bore necessary for thermal expansion and normal manufacturing operations. From this minimum value the valve passes through three degrees or ranges of control. First, the flow is controlled by a notch in the spool for small flow. Second, a ground angle is encountered which increases the flow to a larger amount than that passing through the notch. Third, after coming to the end of the ground angle a full opening is created. This opening is increased until the spool stop is encountered. Reverse flow is the same regardless of the position of the adjustment.

Fig. 5 illustrates how the sliding spool non-compensated flow control valve can be built into a manifold unit to eliminate high pressure piping. In this unit two sliding spool, non-compensated flow control units have been manufactured in a housing that fits between sub plate and body of a solenoid controlled pilot operated four-way valve. They are so ported that they meter the oil out of the cylinder from both ends. Oil enters the cylinder in either direction of flow through the free flow check mechanism.

With the meter-out configuration it is possible to control cylinder movement with a relatively high degree of accuracy. The unit illustrated is widely used in automated conveyor mechanisms. Two independent valves manufactured in a common body permit independent control of the speed of cylinder travel in each direction. The savings in piping and installation are apparent.

Non-compensated flow control and check valves may be used in a meter-out circuit to control the movement of press rams as long as the valve is in no danger of being

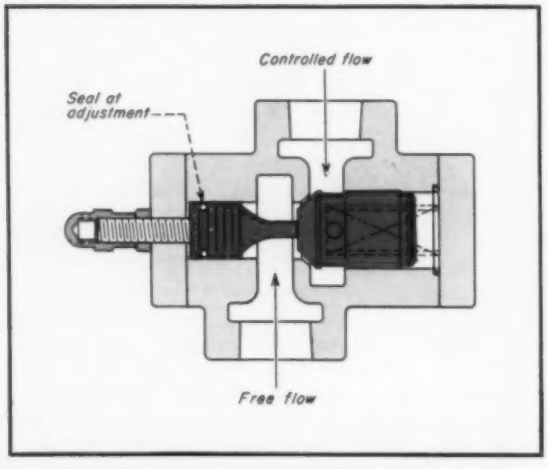


Fig. 3—Poppet type non-compensated flow control and check valve controls flow with a settable orifice in one direction and permits free flow in the reverse direction.

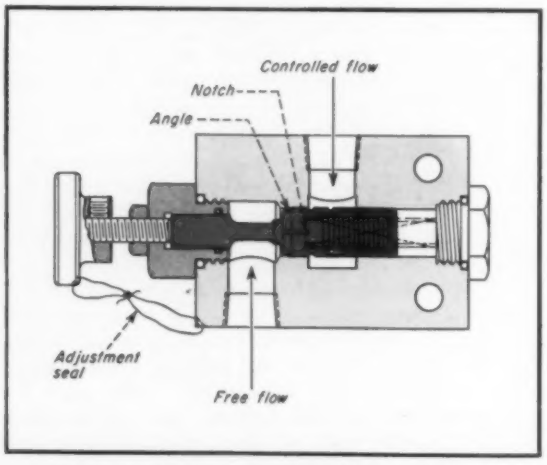
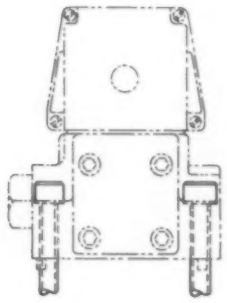


Fig. 4—Finer lead screw and a sliding spool in this flow control valve allows closer flow control. Reverse flow is still free.



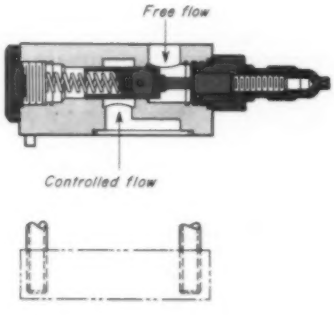


Fig. 5—Sandwich type non-compensated sliding spool flow control and check unit is a dual unit (two valves are side by side) whose housing has been designed to fit between a directional valve and mounting pad.

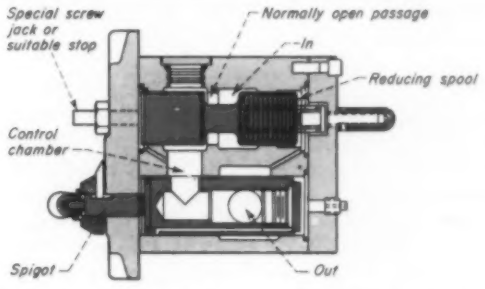


Fig. 6—A compensated flow control valve in which pressure in the control chamber is conducted to one side of the spool and bucks spring pressure plus outlet pressure on the opposite side. Desired flow is set by turning the shut-off spigot to close off the flow path.

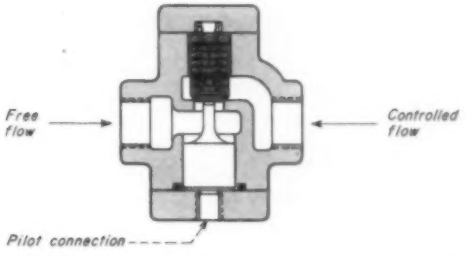


Fig. 7—Basic pilot check valve permits free flow in one direction. Flow is completely stopped in opposite direction until pilot pressure is applied at pilot connection. Pilot piston touches but is not attached to poppet.

accidently shut off. In many installations the ratio between the main ram of a press and the jack rams can be 100:1. The intensification factor is such that piping, packing glands, and cylinders themselves may be destroyed. If flow control valves are used in an application of this type, they should be protected by the insertion of a hydraulic fuse of sufficient value to blow prior to any possible damage to the equipment or operators.

Pressure Compensated Flow Control

Inherent versatility of a commercial, compensated flow control valve will at times create problems. For an applicable range of capacity it is necessary to make the reducing valve of sufficient size to pass maximum flow. This may mean that a relatively small amount of fluid is being controlled by a large valve like the one shown in Fig. 6.

Since the reducing spool is normally open, at small flows the spool may have to travel a considerable distance before it is fully effective. If the machine is stopped during a feed cycle and then started again it may result in a jump of varying magnitude while the reducing spool is moving into a position to effectively control the pressure drop across the orifice. In precision machining operations this can be very serious.

Special models have been manufactured with an adjustment in the compensator spool to limit the amount of opening to a value just slightly larger than the maximum required to satisfy the volume being controlled in the feed operation. In other installations a suitable stop, sometimes a slug, is inserted in the cavity at the end of the spool, opposite from the spring, to prevent the valve from opening to the full extent when the flow through the valve is relaxed. Fig. 6 shows a screw jack for this function.

PILOT CHECK VALVES

Pilot operated check valves are made in three different basic designs. The simplest type are poppets similar to an angle check valve. The poppet is pushed off the seat by a conventional piston when pilot pressure is applied to the rear of the piston. Pilot pressure times pilot piston area must be somewhat greater than contained pressure times poppet seating area to lift the poppet. As shown in Fig. 7, force of the light spring tending to hold the poppet closed must also be overcome by pilot pressure. Ratio of piston area and check seat area varies in different models.

Most single acting pilot check valves are abrupt in opening and throttling is limited. If throttling is required some other valve should be used.

Adequate pilot pressure must be maintained on the pilot of the check to guarantee that it is held open for the requisite length of time. A check valve piloted from a line in which the pressure varies with load will flutter, setting up detrimental shock waves.

A needle valve in the pilot line can be used to control

pilot piston response. If the circuit permits this addition it will often damp out harsh machine operations. However, when the pilot check is a safety device it cannot be damped out.

Normally compression of cylinder or ram fluid is achieved without undue shock or stress, assuming that pressures are commensurate with the machine design. Yield of machine members and slight compressibility of fluid, plus the relatively soft action of a relief valve at peak pressure, or possibly the centering action of a variable delivery pump, will help to avoid shock loading on the compression cycle of a machine. Further, a gradual pickup of work load will often soften the compression cycle. Operations such as coining, shearing, or piercing are exceptions to this characteristic.

In many machines the pressure never rises any higher than the force required to move the work. A good example of this type of circuit would be a broaching machine in which the cutting force is directly proportional to the type of metal being machined, the degree of sharpness of the tools, and the amount of metal being removed. If the tools are sharp, force will be relatively low. As the tools become worn, higher forces are required to push or pull the cutters through the work. Maximum pressures of machines of this type are usually based on maximum possible loading that can be tolerated by the mechanical design.

Decompression Valves

Sudden decompression of these systems may damage or wear circuit components. When abrupt action is undesirable, controlled pilot check action can assist in decompression. A ball or a small piston is first unseated by the pilot piston. A portion of the oil under pressure is released through a small orifice at high velocity to lower the contained pressure to a secondary value. The main poppet then releases at a reduced shock rating. A reduced shock rating is specified because this is usually a relative matter. The higher the pressure with respect to the speed of release, the higher the shock condition. By first releasing oil through a relatively small orifice at high velocities movement of the load mass is slowed until all stresses are diminished.

A two-step decompression cycle is usually adequate for the average machine tool application as achieved by the valve in Fig. 8. In larger press applications it is often desirable to incorporate a three-step decompression cycle.

Three-step decompression checks are made in two basic series. The standard type are manufactured with a pilot piston whose area is smaller than the effective area of the poppet as shown in Fig. 9. A molding press circuit might incorporate a simple ram type cylinder for application of pressure against the closed platens. The press is opened and closed with one or more jack rams, or cylinders. As the jack rams close the press, the main ram is filled by creating a vacuum satisfied through a check valve. After the press is closed, fluid under pressure is diverted into the main ram so that the main ram will build up the desired tonnage on the platens. Area ratios between jack rams and the main ram may be in the order of 100:1. In this case 1000 psi on the jack ram would only create 10 psi pressure on the main ram if oil were locked in the main ram by a pilot operated check.

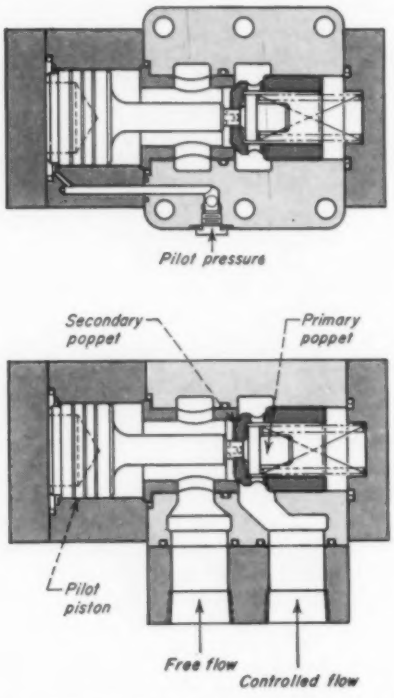


Fig. 8—Pilot check with two step decompression. Movement of the pilot piston lifts the primary poppet opening a small orifice between ports. Further motion of the pilot piston lifts the secondary poppet and opens a large area for flow between ports.

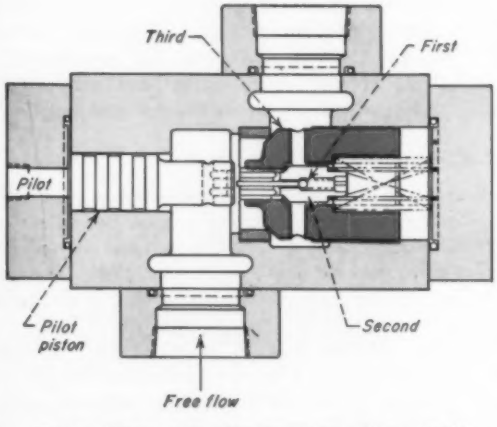


Fig. 9—Three step decompression valve. Initial movement of piston lifts a small ball check off its seat. Additional motion lifts the second poppet widening the reverse flow orifice. Still further pilot piston motion lifts the entire poppet assembly off the main seat. Reverse flow is free.

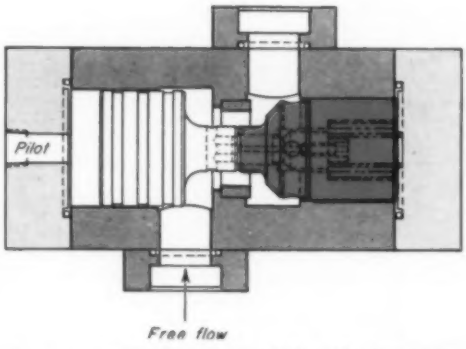


Fig. 10—Large piston pilot check with three step action used for pressurizing a low pressure circuit rather than decompression functions. This valve is shown open under full pilot pressure.

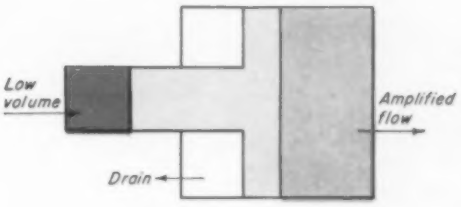


Fig. 11—An intensifier used in reverse will increase flow volume making metering a simpler problem. Low-volume, high-pressure fluid is piped to the small piston. Low-pressure fluid leavs the large side at high flow rate.

Application of 3000 or 5000 psi to the main ram sets up stresses in all of the machine members. When pilot pressure is applied to the piston of a typical pilot check valve for the release of this pressure it first encounters an area ratio of 64:1. Very little oil volume is released, but the contained pressure drops from 5000 psi down to 500 to 1000 psi. The second step unseats the secondary poppet spool at an area ratio of 4:1. This operation normally brings the pressure down to less than 100 psi. The third step completes the decompression.

Some checks have a ratio on the third step of 0.40:1. This means that 1000 psi pilot pressure is necessary to release 400 psi contained pressure. The reason for the negative ratio is to insure smooth operation of the first two steps. If the first two steps do not correctly decompress, the pilot check cannot be opened. By the time the first two steps have been completed opening of the main poppet is not much of a problem because in circuits where the check is used, jack rams do not create large forces or pressures in the main ram. Available pilot pressure is well in excess of the pressures exerted on the check. The first step might open a flow area of 0.0153 sq in.; the second step a flow area of 0.0552 sq in.; the third step a flow area of 1.77 sq in.

A pilot check valve may be equipped with a pilot piston having greater area than the main poppet. In this unit the decompression factor may be less important than the function of opening up a flow in a relatively smooth manner. Units with a large pilot piston are intended to open against a continuing flow of fluid wherein the opening of the pilot check will only momentarily lower the pressure value.

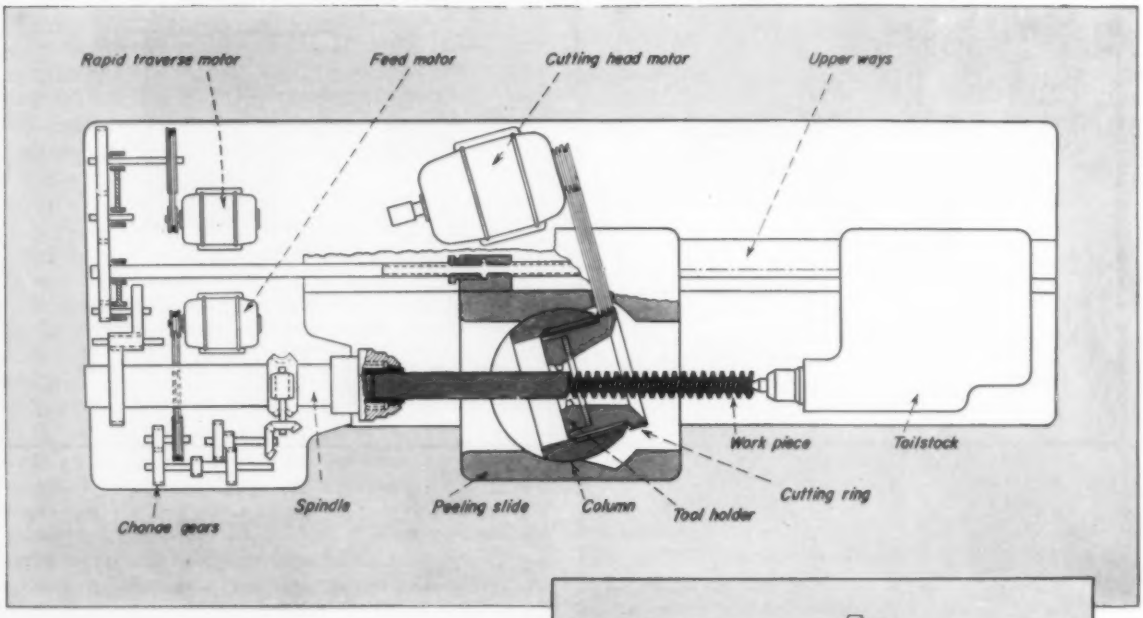
For example, in opening a line from an accumulator into another part of the circuit. The gradual opening through three steps softens the sudden shock of fluid hitting the downstream head at high velocities. Fig. 10 illustrates the relationship of the pilot piston to the poppet seating area. In this particular configuration the values may be 235:1 on the primary opening, 15:1 on the secondary opening and as high as 2.5:1 on the ratio of piston to poppet seat areas. The additional pilot fluid permits use of throttle valve arrangement if it is desirable to control the speed at which the valve opens.

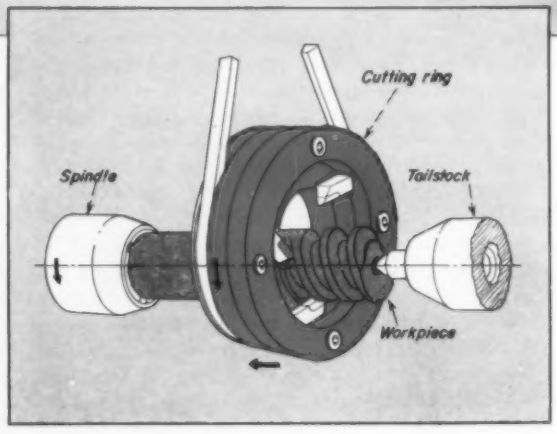
Fine Feed Control

Circuits have been developed in which pilot operated check valves are the key to precise control of machine movements. For small flows in some feed circuits, directional control function is taken over by several pilot operated check valves. The check valves are controlled by conventional pilot type four-way or three-way valves. The check valve either blocks direct flow of fluid from cylinder for stopped position or opens up to a desired orifice to permit uncompensated feed. A second pilot operated check is "teed" in between the blocking pilot operated check and the cylinder that can be opened back to reservoir to permit a rapid traverse when needed. This permits fine feed rates when load and pressure are uniform and a compensating factor is not essential.

Another method of providing an extremely fine feed is to use an intensifier in reverse as shown in Fig. 11. This is then an amplifier of volume rather than an intensifier of pressure. With the assistance of pilot operated checks to channel the fluids in the proper manner, meter-out oil from the cylinder would be directed to the small diameter piston in the intensifier. Oil from the large diameter piston would be directed through an orifice (either compensated or not compensated) at a rate much greater than the fluid entering the same unit on the small end. The quantity of oil to be controlled would be a function of the length of feed required. The degree of control would determine the amount of amplification.

Note that a limited stroke is involved and an intensifier must be chosen of sufficient size to handle maximum length of feed. In addition, circuit operation must permit resetting the intensifier to its start position before further feeds are attempted.

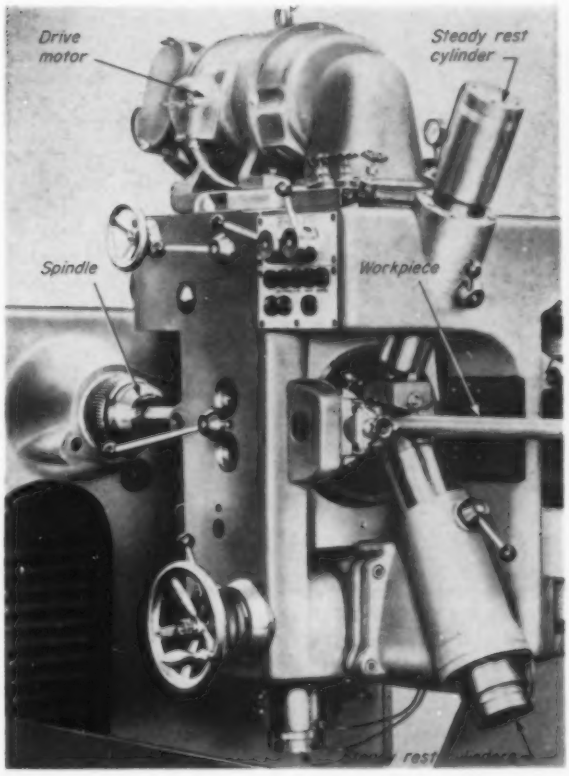




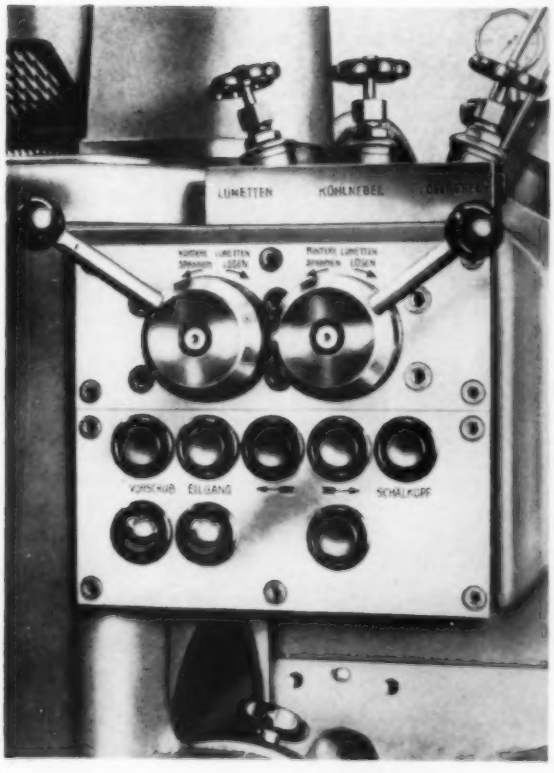
CONSTRUCTION is similar to that of a lathe with ways in vertical plane at rear of machine. Cutting ring and its drive motor are mounted in a heavy peeling slide supported by the ways and advanced by the machine's lead screw. Workpiece is inserted through hollow headstock spindle and the tool ring and is supported by the tailstock. When cutting threads, workpiece and leadscrew are driven by the same motor through change gears; leadscrew is driven by a second motor for high speed return. Workpiece and cutters rotate in same direction, but at different speeds. Workpiece is turned slowly, while cutters revolve at high speed.

Rotating Cutters Peel Threads At High Speeds

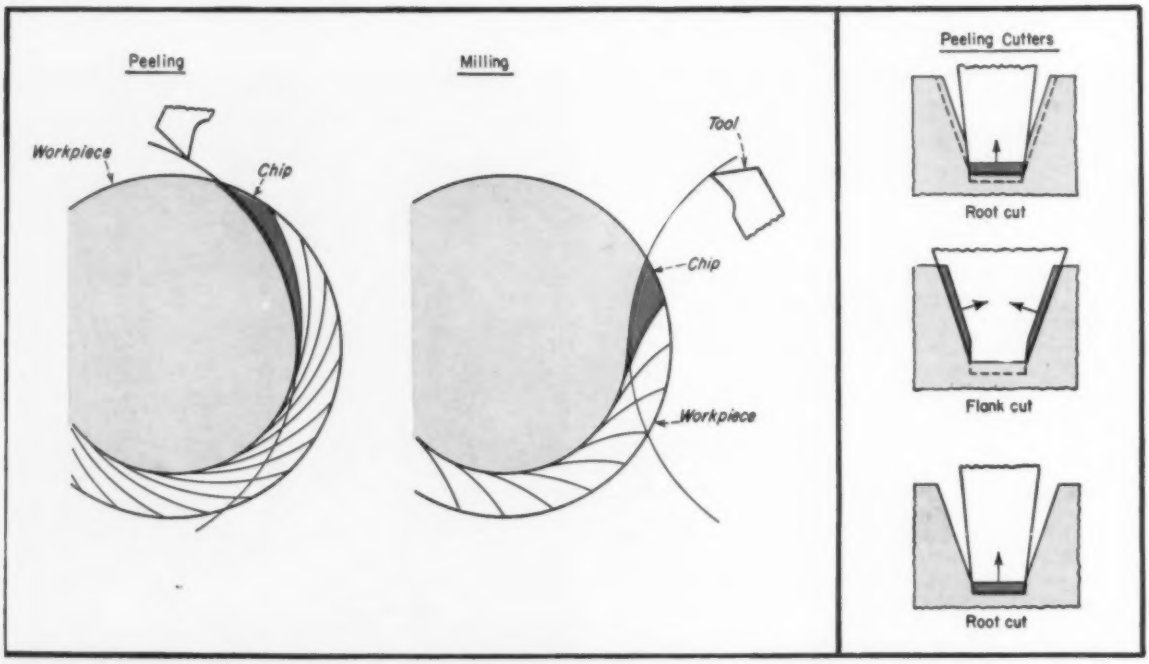
Carbide tipped tools held in a ring which rotates at high speed around the workpiece peel stock from long bars to make single or multiple thread screws. Developed by the firm of Adolf Waldrich, Coburg, Germany, this thread peeling machine uses a cutting principle combining actions of turning and milling. Threads of high accuracy and excellent finish are produced much faster than they can be milled. Tools are cheaper and more easily sharpened than milling cutters for the same job, and last over 3 times as long between sharpenings. Thread is cut by slowly turning workpiece while the cutting ring feeds the tools.



CUTTING RING runs in special double-row ball bearings, mist lubricated, in a cylindrical cast iron column with a vertical axis. Column is rotated to desired lead angle by a handwheel and worm drive; a second hand wheel moves it vertically in the peeling slide. Vertical adjustment sets eccentricity between cutter fly-circle and workpiece to determine depth of cut, which is read from a dial indicator. Drive motor is on top of the slide and drives peeling ring through a V-belt transmission. By using a dc motor controlled from a potentiometer on the slide, a 6 to 1 stepless speed range is obtained. Arms on each side of slide support the workpiece from above and below, and are adjusted to workpiece diameter with graduated nuts. These back rests are engaged and disengaged pneumatically, and are clamped in the engaged position.

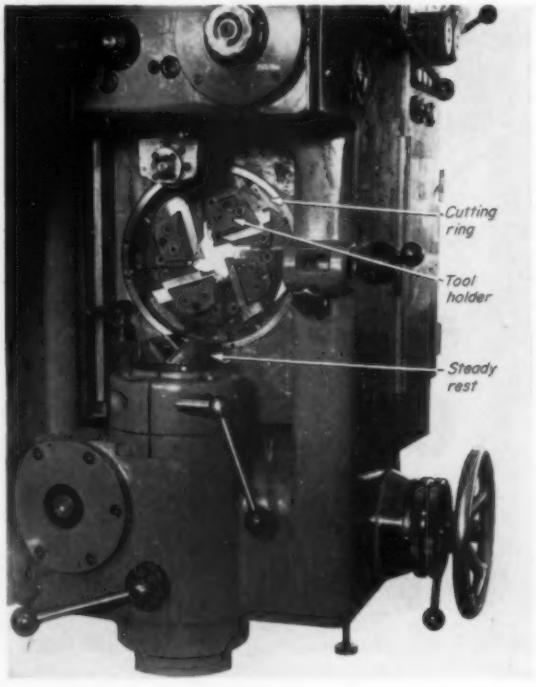


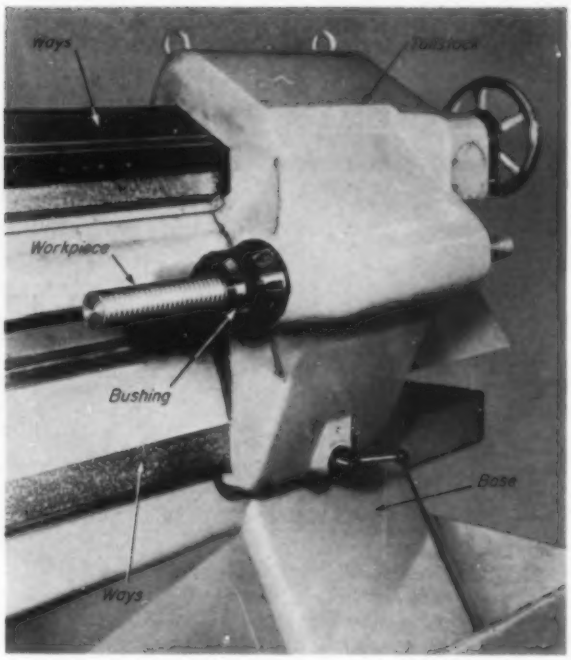
CONTROL PANEL is mounted on peeling slide and contains pneumatic controls for workpiece clamps, and electrical controls for drives. Automatic limit switches prevent slide from contacting spindle and tail stock, and prevent switching to high speed return drive when tools are in cutting position. Also, controls are provided for the lubrication spray and air cooling devices. Pushbuttons control feed, rapid power traverse, tool box motion and cutting ring drive. Lubrication spray system is provided with automatic controls.



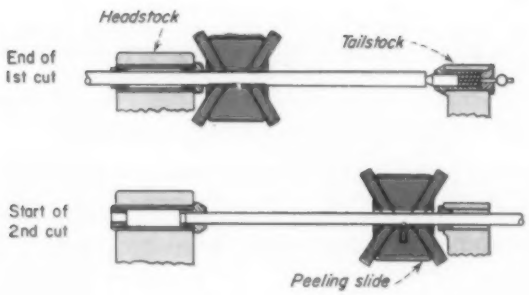
INTERNALLY TOOTHED cutting system was selected over milling cutters to obtain high cutting speeds, minimum tool vibration, and maximum workpiece rigidity during the cutting operation. Also, milling cutters were excluded because a tool with many cutting edges is liable to influence surface structure. It is not possible to include a drive gear and flywheel on the milling spindle with sufficient diameter to keep tool speed variations inside limits required for high accuracy. With same feed angle, peeled and milled chips have same cross-sectional area; peeled chip is longer and thinner, and requires a smaller and more uniform cutting force. For equal maximum cutting force, feed angle for peeling can be 3 times angle used for milling. Simple trapezoidal form of peeling tools is profiled with an accuracy of ± 0.00008 in. and a thread angle accuracy of ± 1 min. Tool which cuts thread root is followed by tool which cuts both flanks, and then by a second root cutting tool; the fourth tool removes burrs. Only root cutting tools, which are diametrically opposed, require critical adjustment.

CIRCULAR TOOL CARRIER conserves space, and makes use of interchangeable carbide tipped tools possible. Best solution to cutter arrangement problem was a position nearly tangential to the workpiece. Cutters are held in close-tolerance slots in the holder, pressed against longitudinal stops, and then clamped with 2 screws. This method is simple, reliable, and allows fast tool changes. Tool holders themselves are adjustable transversely to tool slots in grooves in the cutting ring. Holders are adjusted for the required fly-circle radius with a special fixture. Close approximation of fly-circle to workpiece diameter is a key factor in quiet operation and high quality work obtained with the peeling process. When cutting screws in easily machined material, pitch-line diameter accuracy and lead accuracy deviation from the master lead screw of ± 0.0005 in. are obtainable. Accuracy is measured over a 12 in. length.

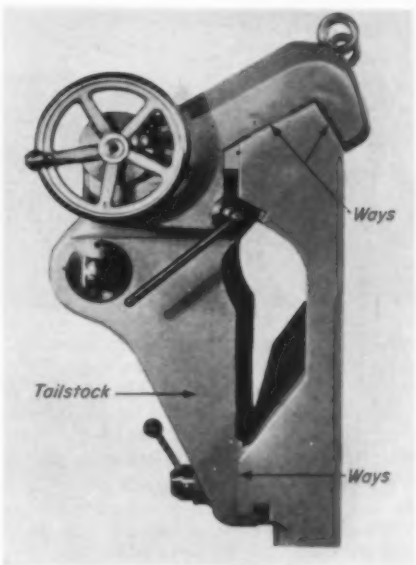




ROOF-SHAPED upper slide and lower flat slide support the tailstock which is moved by a handwheel and rack. Tailstock spindle is hollow and holds either a spring loaded center or guide bushings. For very high accuracy, the peeling machine must operate in a temperature controlled room, or in a plant area where temperature is relatively constant.



SCREWS longer than the machine are cut one section at a time. By using a bushing in the tailstock, instead of a spring loaded center, successive sections are cut while the finished screw is fed out tail end of machine. Each time peeling slide reaches headstock, it is reset to starting position without disturbing relationship between workpiece and cutting ring.

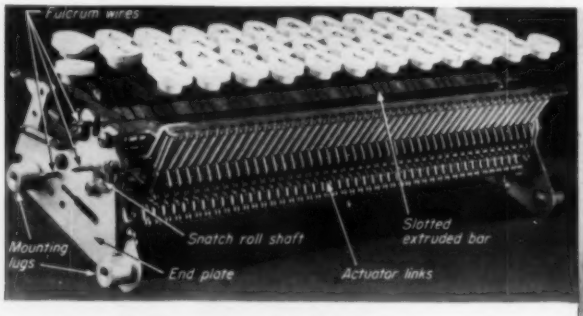


BACKBONE OF MACHINE is the "V" shaped bed. Placing ways in vertical plane with weight supported above cutting axis keeps supporting surfaces close to the cutting axis, and reduces possibility of damage to the superfinished surface by chips. The lead screw, which does not run full length of machine, is housed in a lateral recess.

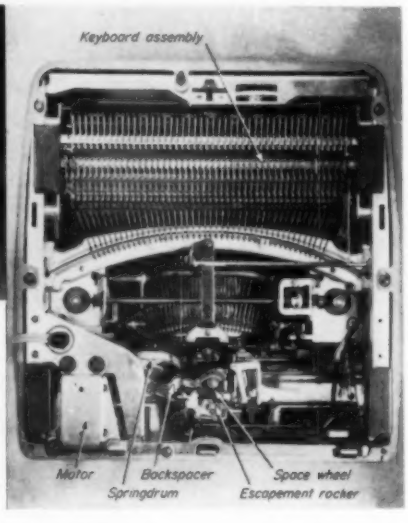
OBJECTIVE WAS to produce a portable typewriter on which inexperienced and unskilled operators could produce work of a uniform quality, with less effort than required with existing portables. Electrifying all printing mechanisms and motions involving effects of rhythm makes writing quality independent of the operator's touch; also, reduced key motion on the electric machine enables more skillful typists to increase their typing speed. Powered mechanisms include printing keys, space bar and shift. To keep weight down and reduce mechanism complexity, operations which normally break continuity of rhythm are still mechanical. These include carriage return and line spacing, back space, tabulator, and margin release. Powering these motions would increase size, weight, maintenance and cost with little gain in performance.

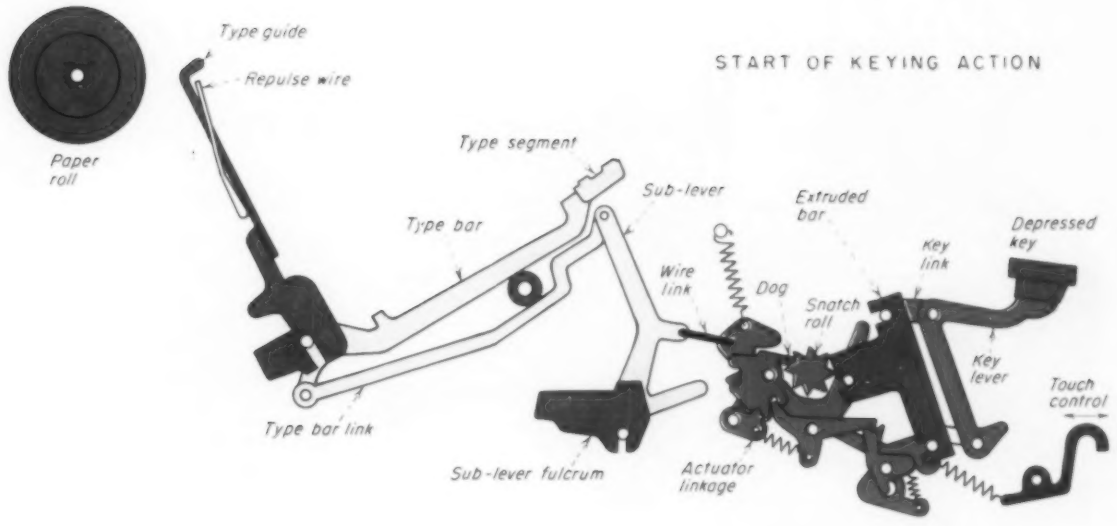
Electrified Portable Typewriter

An electric portable typewriter only ½ in. higher and 5 lb heavier than its mechanical predecessor has been developed at the Groton, N. Y. plant of Smith-Corona Inc. Designed for a market among professionals and small business men, the machine enables inexperienced typists to produce uniform work. Design problems included installation of a lightweight motor drive, and developing a compact and jam-less keying mechanism.



KEYBOARD ASSEMBLY is unitized and held to frame by 2 screws at each end. Required factory adjustments are made on this subassembly before it is put into the machine. Operating parts which require occasional service are accessible from bottom of the machine, as area behind sub-lever fulcrum is free of printing mechanism. This simplified evolution to electric operation by providing space for the drive motor; problem was then reduced to getting adequate power in as small a motor as possible, and developing a simple drive for the keying mechanism. Power is transmitted to keyboard assembly through elastic belts which run alongside the frame from motor to snatch roll.

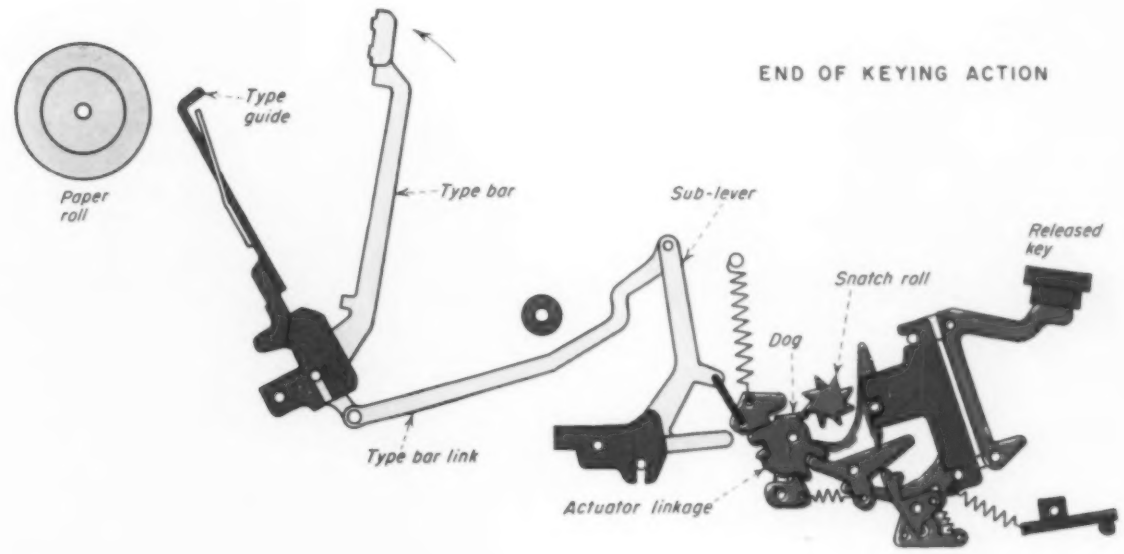


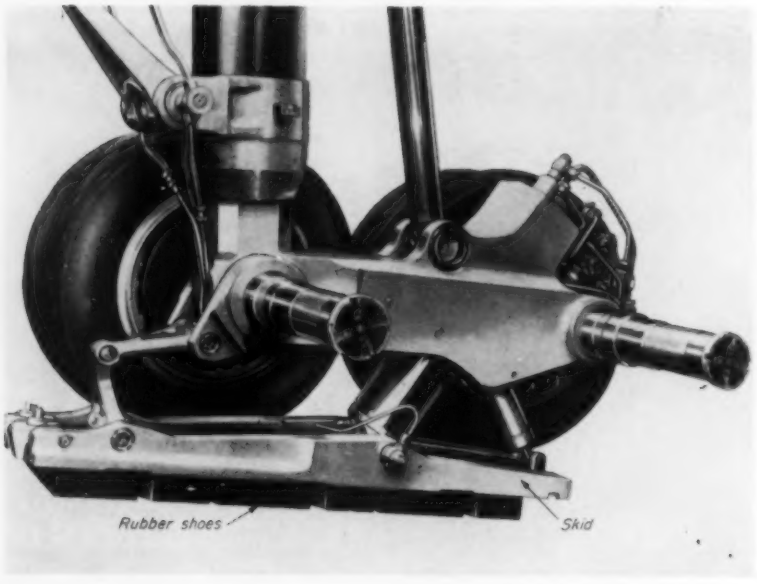


LINKS FOR KEYS, and the actuator linkage, are aligned by slots milled in an extruded aluminum bar, and pivot on fulcrum wires which serve as dowels to position the assembly rigidly in its end plates. Snatch roll is supported in self lubricating bearings. Key links, actuator linkage, and snatch roll are all in the unitized keyboard assembly; sublever and type bar linkage pivot in members mounted directly in the frame. Wire links are only connection between sublevers and mechanism of keyboard assembly.

Depressing key moves pawl on actuator linkage into slot in snatch roll (upper diagram). Linkage is designed so a spring actuated link cams the pawl into position with about $\frac{1}{8}$ in. key motion; additional motion does this mechanically. Once pawl is picked up by snatch roll, key can be released. Actuator link then rotates with snatch roll, until pawl disengages, and accelerates type bar toward paper roll; lower diagram shows linkage position when pawl is about to disengage. A repulse wire at the type guide momentarily absorbs sufficient energy from the moving type bar to fling it back to starting position. Depressing key below point of mechanical engagement holds actuator in position to automatically repeat character.

Printing mechanism had to be fool-proof as the machine will be sold through a wide network of dealers and through mail-order houses. After leaving factory, no set-up or service will be available before user operates the machine. Structure must take shocks and strains of shipment and still operate properly. Frame is an assembly of steel stampings enclosed in a drawn steel jacket which is made with dies used for the mechanical machine, with an additional $\frac{1}{2}$ in. of skirt height to allow for the motor.

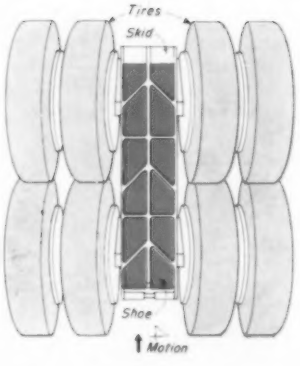


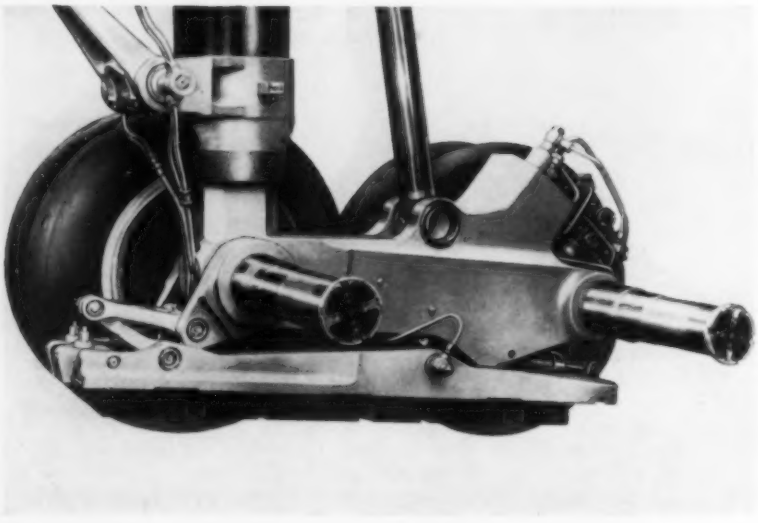


SKIDS are lowered and jacked against the runway hydraulically until they absorb 80 per cent of vertical reaction forces to develop maximum braking action; balance of weight is carried on tires to obtain proper dynamic stability. This weight distribution is maintained throughout landing run with a hydraulic control system actuated by a sensing element which measures oleo displacement. In photo shown, 2 wheels have been removed.

Expendable Brake Shoes

Retractable skids lined with expendable rubber shoes have replaced disk brakes on a British bomber. Developed by Dowty Equipment Ltd., Cheltenham, England, this brake design reduces weight of the undercarriage by 25 per cent, reduces tire wear, and improves braking action on slippery surfaces by squeegeeing water from under the shoes.



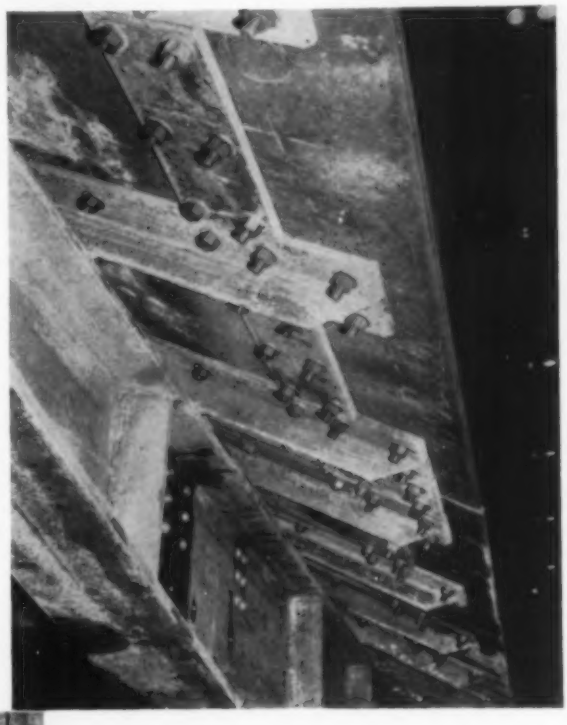


SYNTHETIC RUBBER was selected for the shoe material to obtain low heat conductivity and a high coefficient of friction. In addition, the rubber is hard enough to resist tearing, and sufficiently resilient to conform to minor surface defects. Wire reinforcements were abandoned as they caused shoes to overheat. Wearing surface is made of 3 rubber shoes chemically bonded to backing plates which are positioned in the skids by tenon slots at rear and quick release fastenings in front. Herringbone grooves in the rubber shoes throw abraded material and water out sides to reduce surface lubrication; shoes last for several landings. When retracted, skids rest against axle beams.

Stud Welding Floor Plates Lowers Cost of Coke Cars

Fastening floor plates to the undercarriage with welding studs instead of bolts reduces shop costs and increases service life of coke quenching cars used at the Fairless works of U. S. Steel Co. Abrasion, corrosion and thermal shock made frequent replacement of bolted floor plates necessary. Plates fastened with welding studs last at least 50 per cent longer and cost less to install.

FIRST, plates of high strength steel were used in place of mild steel plates for higher abrasion resistance. This change increased service life, but did not reduce shop costs. Experience indicated the fastening method, not plate material, was key factor in lowering shop costs. Damage to floor plates is caused by abrasive action of hot coke, corrosion by acids which form in the quenching water, and strains from thermal shock during quenching process. Cars are loaded with 2100 deg F coke and then quenched with cold water every 10 min. Bolt heads were sheared off by the plates, or eroded by the acids; leakage through bolt holes also corroded the car's undercarriage. Once bolts were destroyed, the plates buckled and pulled loose, and a complete replacement of floor plates was required every 15 or 16 weeks.

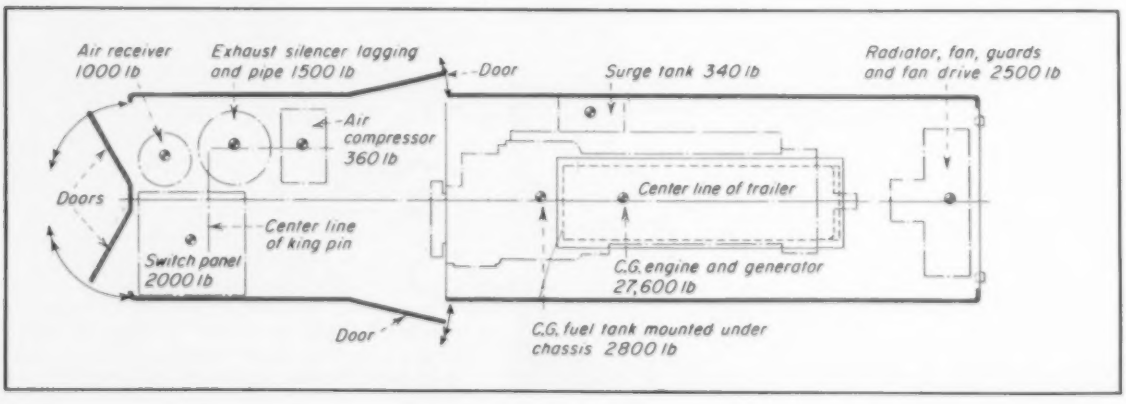


PLATES fastened with welded studs form an uninterrupted floor surface which reduces leakage of corrosive quenching water onto studs and car's undercarriage. Mild steel plates are used as the new fastening method increases service life sufficiently without going to a more specialized steel. Operating time between floor plate changes is about 50 per cent longer than with bolted plates. With the bolted-plate method, new plates were moved from one shop to another for various make-ready operations. Several plates could be gang-drilled, but holes were countersunk individually. Plates were flame cut to size in the structural shop, then moved to the machine shop for drilling and countersinking. Now, shop costs for making and installing floor plates are lower as no machine shop work is needed to prepare plates for assembly. Plates are flame cut to size, and studs are welded in place with a simple template. Studs are made by KSM Products Inc., Merchantville, N. J.

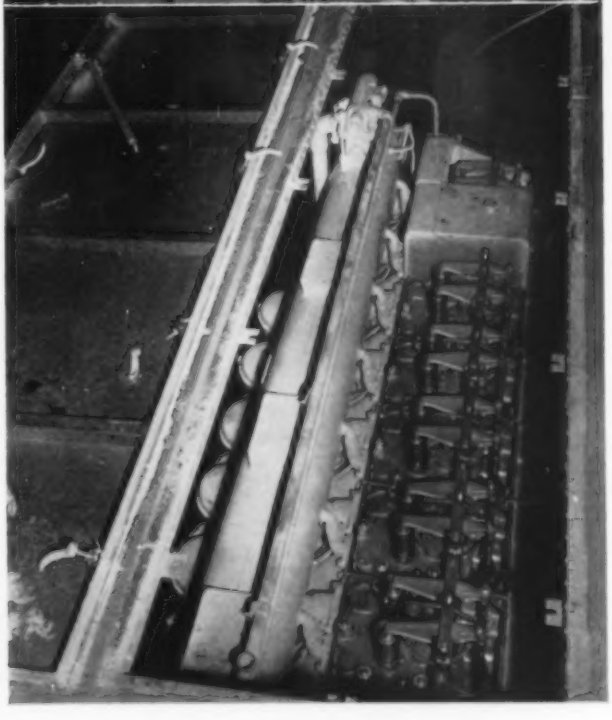
Trailer Houses Generating Plant

500 kw diesel-generator sets, complete with controls and fuel, are housed in tractor-trailer units to supply industrial and municipal power systems in newly developed areas of Venezuela. Designed by the White Diesel Engine Division of the White Motor Company, Springfield, Ohio, the generating plants can withstand off-the-road transportation strains, and will operate continuously for over 20,000 hrs between overhauls. Specifications required units to be self starting, run with little maintenance, and need one operator. Electrical equipment is insulated for the high temperatures and humidity of the tropic climate, and the diesel engines deliver rated power from sea level to over 5000 ft.

WEIGHT AND SPACE were critical factors in equipment layout. Trailer had to conform to legal limitations for U. S. highways, and equipment centers of gravity had to be positioned for adequate stability when maneuvering over off-the-road terrain. Also, ample space was required for operator, and for basic maintenance procedures. Engine and generator unit assembly is heaviest and is installed as far forward as possible to improve weight distribution between kingpin and rear axles. Control panel and air compressor are in front of the trailer, while radiator and fan for diesel are at rear. Door openings at front provide access to rear of control panel. Trailer frame was strengthened by increasing depth of longitudinal channels to increase bending strength and torsional rigidity.


Air receiver 1000 lb
Exhaust silencer lagging and pipe 1500 lb
Door
Surge tank 340 lb
Radiator, fan, guards and fan drive 2500 lb
Air compressor 360 lb
Doors
Center line of trailer
Center line of king pin
Switch panel 2000 lb
C.G. engine and generator 27,600 lb
Door
C.G. fuel tank mounted under chassis 2800 lb

ENGINE AND GENERATOR are mounted on a locomotive bedplate modified at the generator end for increased support. This allowed use of a light frame generator to reduce weight. Exciter is over generator to decrease length, and is driven by V belts. System generates power at 2400 v for compatibility with existing transmission systems; load is connected at through-type insulators above the control panel access door. External transformers adapt unit to 13,800 v transmission system now under construction. Fuel for 12 hr operation is carried in tank under trailer. Switchboard is supported at floor and side wall on shock mounts.

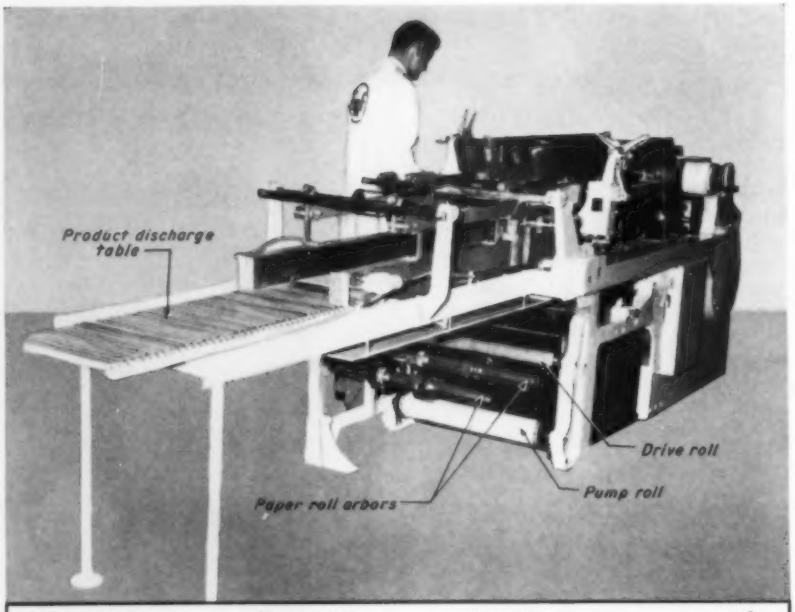


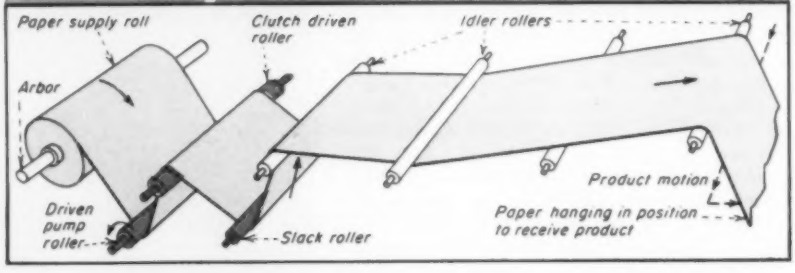
ACCESS DOOR in roof panel simplifies engine overhaul as head, pistons and connecting rods can be removed with unit in operating position. Engine is equipped with audible and visual alarms for low oil pressure and high water temperature with silencing switch and test button at the control panel. An overspeed trip, built into the engine, is reset with a manual lever. Engines will operate using either oil or natural gas with pilot fuel injection for ignition. Unit is equipped with a special intake air filter for desert operation, and an exhaust silencer adequate for service near hospitals and public buildings. Inside walls and roof are undercoated to reduce sound transmission.

FAN FORCES air through radiator and discharges out rear opening. Louvers in side walls admit air for ventilation and engine cooling; a bulkhead forward of rear louvers restricts air flow to keep velocity in passage around engine within range comfortable for operator. Trailer weight is jacked off tires when in operating position to prevent coupling with engine vibrations. Body is framed with 1½ in. square steel tubing, covered with aluminum panels, and is grounded to metal stakes driven into the ground.

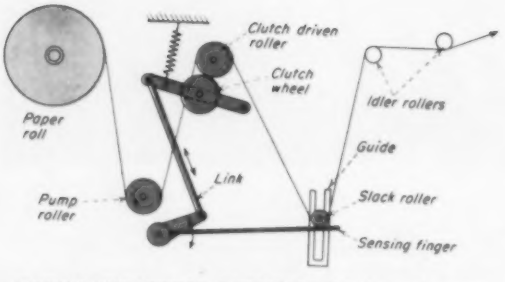
Clutch Drive Controls Paper Feed

A friction clutch wheel, in the self-measuring paper feed drive, synchronizes paper motion with product feed in the new high-speed wrapper made at the Brooklyn, N. Y. plant of American Machine & Foundry Co. Machine was developed by Bakery Equipment Engineering Dept. under direction of F. L. Waite, Chief Engineer. Clutch engagement is controlled by position of a slack roller to prevent over-feeding following interruptions in product feed.

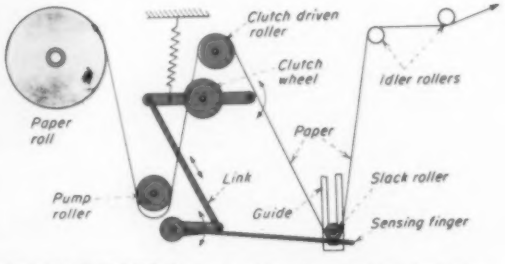




POWER DRIVEN pump and drive rollers pull paper from supply roll at rate required to meet average product feed. Intermittent higher feed rates are supplied by upward motion of the slack roll which momentarily shortens paper path. Previous designs depended on paper tensions to control friction between paper and drive rolls to vary feed rate. Supply roll inertia and normal contact friction between paper and rollers caused overfeeds following interruptions in product flow. Clutch and drag brakes in new design prevent overfeeding by controlling roller motion directly.



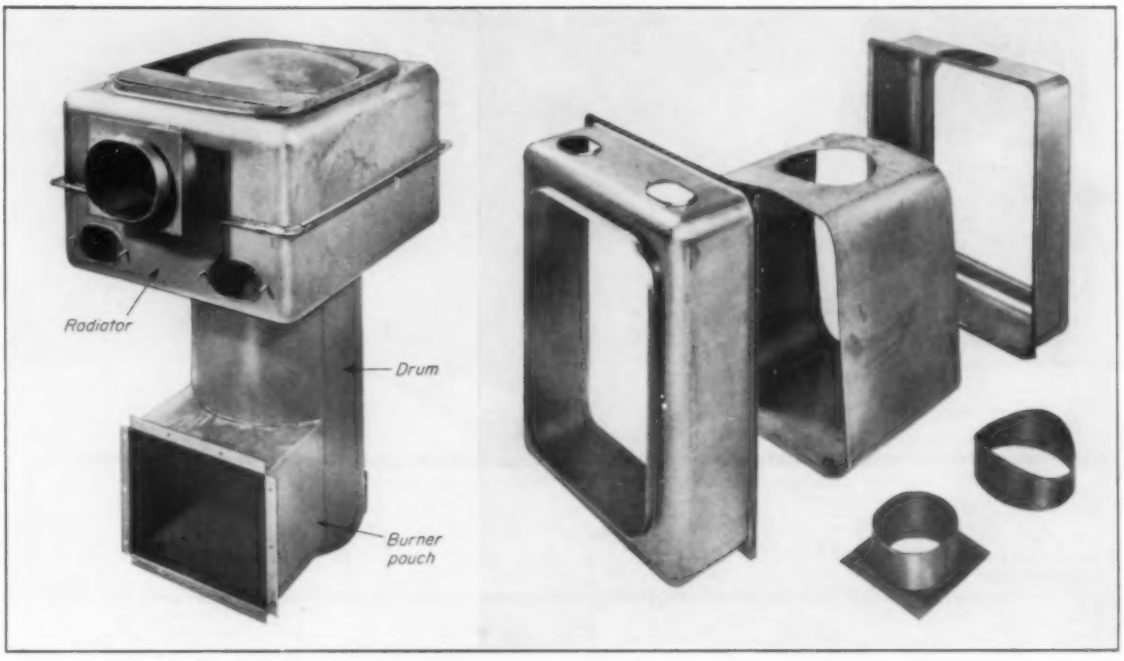
WHEN WRAPPING MECHANISM demands paper, increased tension raises slack roller and allows spring loaded sensing finger to rise. Clutch wheel then engages drive roller which pulls paper against pump roller; combined action of pump and drive rollers feeds paper at rate required to meet average product feed.



SLACK ROLLER lowers sensing finger when feed rate exceeds demand, and clutch is disengaged from drive roll. Spring type friction brakes overcome inertia of drive roller and supply roll to prevent paper pile-ups during interruptions in product feed. Paper hangs slack around pump roller which continues to rotate.

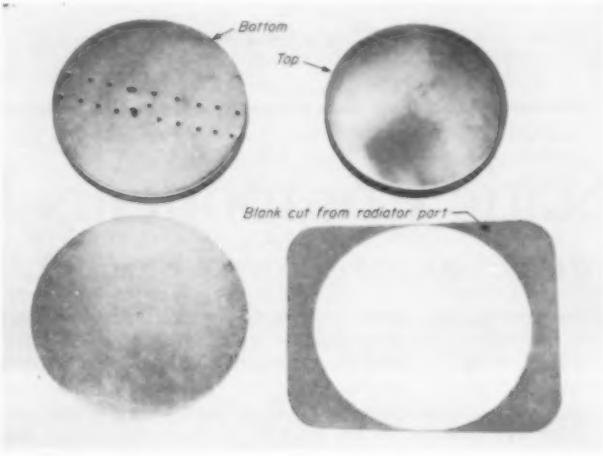
Stamped Parts Reduce Welding

Redesigning radiator of a heat exchanger to use drawn and stamped parts in place of brake-formed sheet metal parts reduces the amount of arc-welding required at assembly and increases the unit capacity of welding shop. Designed by Mueller-Climatrol Co., Milwaukee, Wis., for use in their line of home heating furnaces, the radiator now has 5 parts instead of 8.

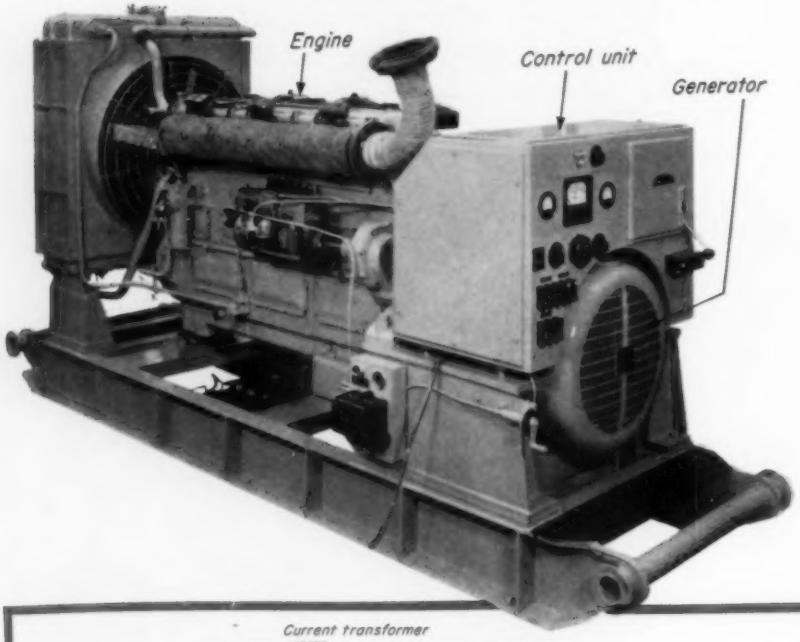


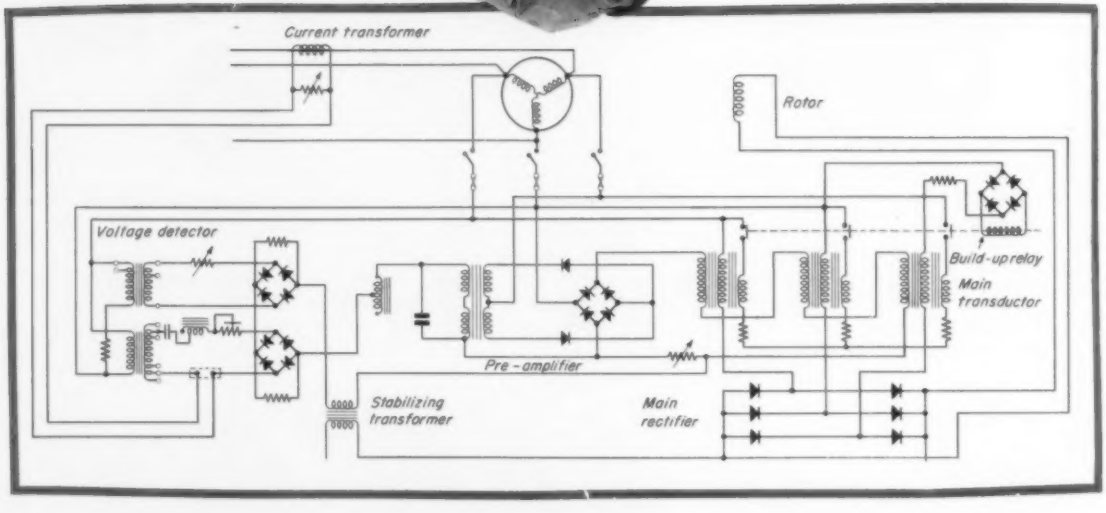
REDESIGN WAS PROMPTED by production volume reaching capacity of welding department. Reducing parts from 8 to 5 and use of drawn sections reduced total length of welded joints, and allowed greater use of seam and spot welding in place of slower arc-welding. Although drawn and stamped parts required investment in dies and presses, savings in material and labor costs combine with higher volume to produce an adequate return on the investment. Unit capacity of welding department is now 78 per cent greater than with the old design.

CUTOUTS from drawn parts of radiator are used to form top and bottom of heat exchanger drum. Using fewer and simpler parts has cut down amount of scrap material and thereby lowered material costs. Further cost reduction was obtained by redesigning burner pouch and drum; pouch is now smaller in all 3 dimensions and has a narrower flange at its open end. Fabrication time is 40 per cent less, weight of parts has been reduced from 77.3 to 63.4 lb, and scrap weight is now 5.3 instead of 6.5 lb.



Static components are used to control excitation and voltage regulation in a lightweight generator built by Brush Electrical Engineering Company Ltd., London, England, for portable diesel-generator sets. Weight of a 100 kw unit using this system is 1500 lb, compared to 2450 lb for a similar unit with a rotary exciter; overall length is reduced from 5 to 2½ ft. Generator armature is stationary, while a yoke, carrying the field coils, revolves around it. Yoke, which is coupled directly to the engine, replaces the flywheel to reduce weight, length and cost.



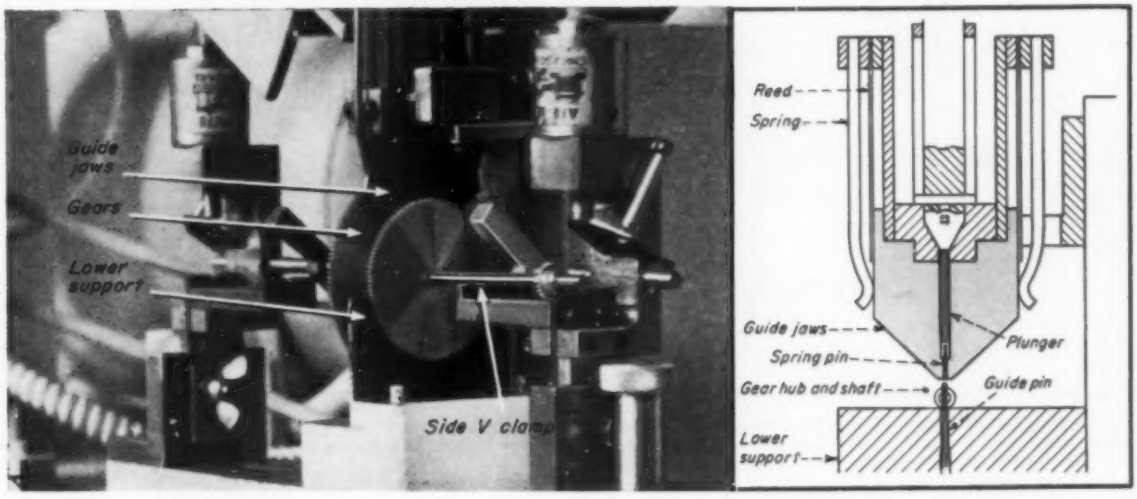


Static Components Excite Generator

EXCITATION AND VOLTAGE CONTROL SYSTEM uses static components such as magnetic amplifiers, rectifiers, condensers, transformers, chokes, and resistances. Main generator field is energized from a rectifier, input side of which is connected across the generator output terminals through a transductor. Transductor's saturating winding is energized by a magnetic amplifier which is, in turn, energized by a voltage detector unit connected to the generator terminals. Variations in terminal voltage are detected, amplified, and applied to the saturating winding of the transductor to change its reactance, and modulate the field current. Because forward resistance of the main rectifiers is high, generators residual voltage must be boosted to ensure that voltage build up occurs. This is done with an auxiliary winding on the main transductor. The winding is energized by a starting relay and cut out of the circuit when voltage is sufficient to insure satisfactory build up.

Machine Pins Gears To Shaft

Gears spaced ⅛ in. apart are pinned to small dia shafts with grooved spring pins by an assembly machine developed at Aidlings Inc., Brooklyn, N. Y. Pins are hopper fed to guide jaws, and then pressed into pre-positioned holes by an air-driven plunger.



SHAFT AND GEARS are positioned manually on lower support and side "V" clamp, with guide pin through hole in which spring pin must be placed. Action starts with a spring pin in the guide jaws which move down to contact the gear hub. Drive plunger then starts moving spring pin which centers itself on conical point of the guide pin and is supported throughout operation. As spring pin is pressed into the hole, it pushes spring-loaded guide pin into lower support. Machine is an adaptation of unit described in October 1956, page 149, but uses only upper plunger drive.

Humidity-free drying is obtained in the Waste King Corp. dishwasher by heating dishes to 160 deg F, and then circulating room air outside the tub to condense moisture on its inside wall.

Knots are tied automatically by driving thread through passages in scissor-like nozzle plates with compressed air, in a sausage tieing machine made by G. H. Sachsenroeder, Wuppertal, Germany.

One fixed and one free bearing are used in a new line of centrifugal fans made by American Blower Corp., Detroit, Mich. Sleeve bearing is designed so sleeve can be removed from housing without disturbing bearing support.

Nickel-chrominum resistance wire in the heating element tip of an instant solder gun has good corrosion resistance at high temperatures, and prevents damage from overheating. Gun is made by Hexacon Electric Co., Roselle Park, N. J.

Neoprene blocks have replaced springs in automotive replacement clutch plates.

Phenolic impeller, which runs at 1750 rpm, in the Rheem clothes dryer is compression molded on its steel shaft by Chicago Molded Products Corp.

Laminated plastic sliding vanes reduce wear in a rotary-vane air compressor made by Ingersoll-Rand.

Springs inside the objective tube focus a "Follow-Focus" lens made for rapid action shots by Novoflex Fotogeractebau, Memmingen, Germany. Unit has a pistol-grip, and is operated by squeezing a trigger.

Hydraulic cylinders in the rear wheels form two 5-cylinder radial motors which drive a tractor at speeds up to 6 mph. Developed by the National Institute of Agricultural Engineering, Silsoe, England, the machine is powered by a diesel engine which drives a variable displacement piston pump. Piston thrust is directed against shoes which ride an eccentric bearing on the stationary axles.

Honeycomb sandwich flooring is used in the Handley Page "Herald" aircraft. Made with aluminum honeycomb and skin, it can be used at skin stresses up to 50,000 psi.

A turret carried on a swinging arm receives work pieces from a loading chute, positions them for grinding, and then discharges them to unloading rails. Device is used on grinders made by the Norton Co., Worcester, Mass.

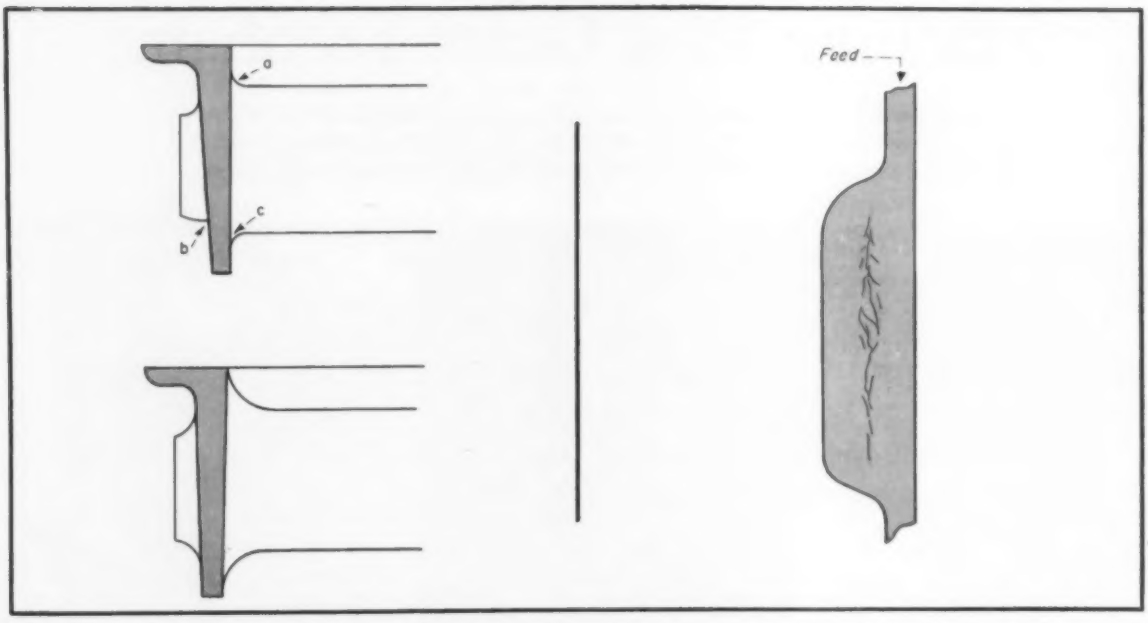


Fig. 1—At top, insufficient fillet (a), sharp corner (b), and quick change from thin to thick section (c) invite failure. Bottom, note how these shortcomings are overcome.

Fig. 2—Centerline or channel shrinkage occurs when a heavy section is fed through a light section.

QUALITY and COST of

How to avoid common design factors which cause unsoundness or increase the cost of magnesium sand castings.

FELIX M. GIORDANO
Assistant Editor

Functional failure and high cost are the result of improper design of many magnesium sand castings. As a result, magnesium sand castings are not as popular as they could be.

Causes of Failure

Some design features naturally produce cracks in the casting. Skimpy fillets, sharp corners, quick changes from thin to thick section, Fig. 1, are always invitations to disaster, but especially so when found in magnesium castings. The cooling pattern induced by these design features is such as to produce large stresses which, in a metal as rigid as magnesium, often result in tiny surface cracks that act as nuclei for fatigue failures.

On the other hand, the cooling pattern of an isolated heavy section results in a frozen shell of metal enveloping a liquid core. Upon further solidification, the core tries to contract, resulting in stresses which are above the strength of the mushy core, but below the strength of the frozen outershell. As a result, the core gives, resulting in the typical magnesium shrinkage. If the heavy section is relatively long, the shrinkage becomes "centerline" or "channel", Fig. 2.

Both surface cracks and internal shrinkage mean scrapped castings, but a properly controlled solidification process can be made to produce sound, dense castings.

Use ample fillets. Round corners. Pass from a thick to a thin section as gradually as you can. Make metal flow from a heavy to a thinner section.

The aim is to obtain progressive solidification as in Fig. 3, starting at the thin part of a casting and ending in the risers.

Parts containing pads or bosses, Fig. 4, often fail because the designer tried to reduce a little weight. Blending of pads or bosses into the casting wall with a gradual taper avoids sudden change in section size and consequent weakening of the part on cooling. The function of pads and bosses is to hold other parts, so they need to be stronger, if anything, than the rest of the casting.

Cost Boosters: Molding

A magnesium part is cast in sand either because it doesn't pay to go to permanent mold or die casting, or because it is so intricate and big no other process could do the job at a reasonable cost. In either case, cost is a pretty big factor. To put into such a casting features of design

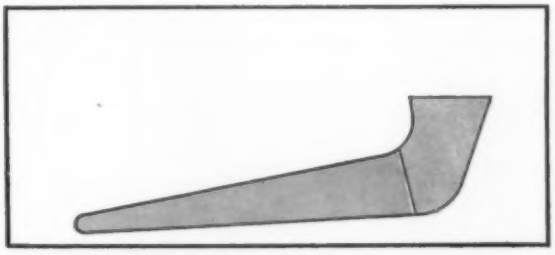


Fig. 3—In this casting solidification progresses from thin to thick end, the latter connected to reservoir of molten metal.

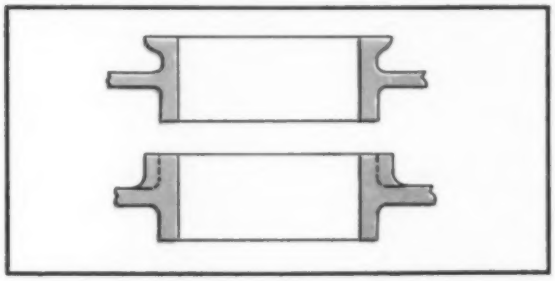


Fig. 4—Pads or bosses are likely to come up weak in the design at top. Extra strength where needed is achieved at bottom.

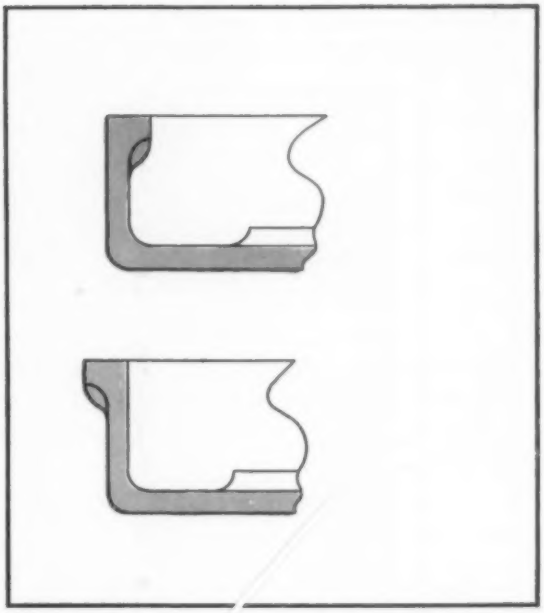


Fig. 5—Loose pieces or a core are required by the design at top. Design at bottom is cheaper.

Magnesium Sand Castings

that increase its cost unnecessarily doesn't make sense.

Gear cases and other box-shaped parts are often designed with flanges and bolting bosses on the inside of the casting, Fig. 5, requiring either loose pieces in the pattern or an inside core. All this does is to jack up the cost of the casting. Outside flanges and bosses would give a simpler and cleaner casting that could be all molded in green sand without loose pieces, and it would be a lot cheaper.

Use loose pieces in the pattern only if nothing else will do the job. The same goes for cores.

For some reason, designers don't like to continue bosses under bolting flanges into the main wall of the casting. In Fig. 4, the design at top requires loose pieces, which mean more molding and trimming. "Tailing" these bosses, bottom, cuts casting cost, and the extra metal strengthens a particularly stressed area.

Draft

To withdraw the pattern from the sand mold, the foundryman needs draft. Too often the designer doesn't allow enough draft or the drawing specifies "No Draft" altogether. You can have "No Draft" if you insist, but you'll pay plenty for it.

Check the blueprint to see that sufficient draft has been allowed. Justify any "No Draft" requirements.

Most foundries require a 2 deg draft allowance, but it isn't wise to anticipate parting lines and add draft from them. Probably no two foundries will pick the same parting line for a given casting. Better specify the draft allowance, but don't draw it in.

Tolerances and Finishes

Sand casting is not precision casting, but some foundries can get very close tolerances and excellent cast surfaces, obtained by special molding techniques and clean-up methods.

While foundries will differ from each other, you can get tolerances as close as ±0.015 in. if needed. But to specify these tolerances on all dimensions of a complicated casting is to ask for high costs.

The same goes for surface finish. Special facing sands and painstaking clean-up methods can produce really superb cast surfaces, but is that fine surface really needed? Often it will be painted before assembly, or it is hidden inside a box-like structure.

Keep to the tolerances shown in Table I. Don't specify finish unless it's needed.

Normal sand-cast finish runs about 400-500 microinches RMS. In addition, most foundries have a polishing operation which improves the surface before the casting is delivered.

Wall Thickness

More and more, designers ask for walls as thin as 0.090 in., and some foundries have developed special techniques to get them. But they aren't cheap.

TABLE I. DIMENSIONAL TOLERANCES FOR MAGNESIUM SAND CASTINGS

Size of Casting	Wall and Rib Thickness with Draft	Wall Thickness Without Draft	Boss, Hub, Pad, Flange Profile and Radius Thickness and Depth	Radius of Oil Line Bosses	Location of Ribs out of Position	Outside Diameters	Inside Diameters
Up to 12"	±.03"	±.03"	±.03"	±.03"	±.03"	+.06" −.03"	+.03" −.06"
12" to 24"	+.06" −.03"	+.02" −.03"	+.04" −.03"	+.06" −.03"	±.06"	+.09" −.03"	+.03" −.09"
24" to 36"	+.09" −.03"	+.06" −.03"	+.06" +.03"	+.09" −.03"	±.09"	+.12" −.03"	+.03" −.12"
Over 36"	+.09" −.03"	+.06" −.03"	+.09" −.03"	+.09" −.03"	±.12"	+.12" −.03"	+.03" −.12"

Tolerances on all fillet radii +.12, −.03"

Use minimum wall thicknesses as per Fig. 6. Justify thinner wall requirements.

Identification Pads

Often a blueprint will show a part that will draw in green sand, all but the part identification, which requires a loose piece or a core. Better relocate it to draw in green sand and cut the part's cost.

Stamping pads, often used instead of identification numbers, are sometimes located on thin surfaces. If properly set for draw, they don't offer any casting difficulty, but when the identification is stamped on the pad, the thin wall may crack. Even worse, the cracking may not occur until the last stamping on a finish machined part. Some foundries now suggest that the design indicate only the general location of a stamping pad.

Leave the exact location of identification number or stamping pad to the foundryman. If it is necessary to detail this part of the casting, keep in mind the problems it can cause.

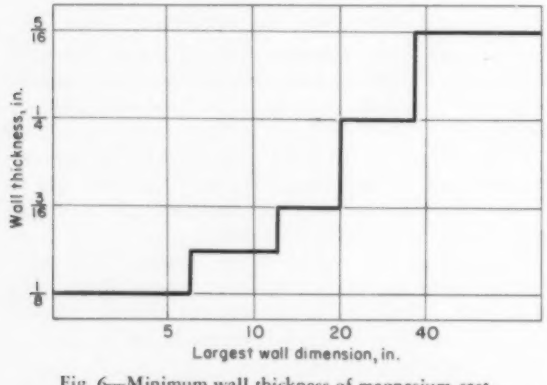


Fig. 6—Minimum wall thickness of magnesium castings. Dimensions are subject to normal tolerances.

Oversize and Finish Allowances

Have a definite understanding with the foundry as to acceptable oversize allowances, to be noted on the drawing. Complex gating, risering and chilling used in casting magnesium requires that bosses, oil lines, pads, hub profiles and similar details should be made to a definite oversize dimension. This varies from 1/64 in. to 1/32 in., depending on casting size. Oversize dimensions are above standard tolerances and are added to the radius. The extra stock compensates for minor shifts between mold parts and insures enough metal around drilled holes.

Finish allowances vary with the size of the casting. The metal is easily machined, so there's no point in skimping; don't leave less than 1/32 in.

Cores

Manufacturers of aircraft parts like to combine two or three parts into a single casting. As likely as not, this practice results in complicated coring arrangements. Simplifying the coring helps to make the part easier and cheaper.

Core supports are a recurring problem. Too often, cored out areas will be shown on a drawing with no provision for supporting the cores in the mold. Designs of cored-out airfoil sections are the worst offenders.

Ribs are not Cheap

Ribs are often used to increase the stiffness of a casting wall, but the use of "T" ribs requires cores, which increase production costs.

A common error is to use "stiffening" ribs across angular intersections. This concentrates stress at the edges of the rib, causing failure. In such cases the rib design is weaker than the design without ribs.

Impregnation

Satisfactory impregnation processes are now available, and should be specified on all parts that must be pressure tight, especially if they are cast in a magnesium-aluminum-zinc alloy.

Observance

To make sure that rules like the ones above don't get broken, one design organization requires that all deviations from standard practice be noted with special characters on the drawings. There is no reason why this practice cannot spread to other organizations.

EDITOR'S NOTE: Valuable information and aid in the preparation of this article has been received from the following persons and organizations:

Horace C. Cook, Aluminum Company of America, Buffalo, New York.

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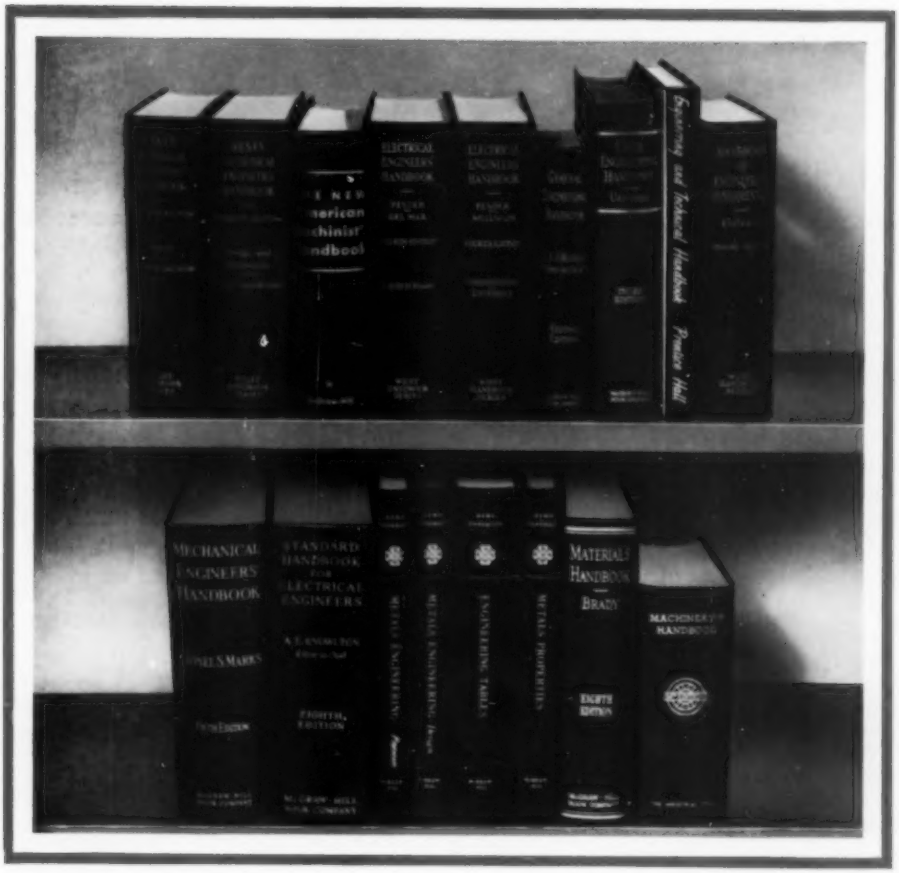
G. R. Sandenburgh, Hills-McCanna Company, Chicago, Illinois.

William Danks, Howard Foundry Company, Chicago, Illinois.

Elmer Lanfranke, Rolle Manufacturing Co., Lansdale, Pa.



THE ENGINEER'S BOOKSHELF

RICHARD M. KOFF-ASSOCIATE EDITOR

Suggestions from many authorities

plus a detailed technical bibliography

Included here:

12 basic handbooks
293 texts in 21 special fields
8 bibliographies
14 general references
4 biographical references
156 periodicals

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Handbooks

American Society of Mechanical Engineers. (ASME Handbook Series.)
Metals engineering: Design, edited by Oscar J. Horger, 1953, 405 p., $10.00;
Metals properties, edited by Samuel Hoyt, 1954, 445 p., $11.00;
Engineering tables, edited by Jesse Huckert, 1956, 705 p., $12.00;
Metals engineering: Processes, in press. McGraw-Hill Book Co.

Brady, George S. *Materials handbook*. 8th ed. McGraw-Hill Book Co., 1956. 1022 p. $11.00.

Eshbach, Ovid W. *Handbook of engineering fundamentals*. 2nd ed.
John Wiley & Sons, 1952. 1394 p. $11.00.

Hoag and McNeese. *Engineering and technical handbook*. Prentice-Hall.
To be published in 1957.

Kent's Mechanical engineers' handbook. 12th ed. Power volume edited by J. Kenneth Salisbury.
Design and production volume edited by Colin Carmichael.
John Wiley & Sons, 1950. 2 vols. $10.00 per volume.

Knowlton, A. E. *Standard handbook for electrical engineers*.
8th ed. McGraw-Hill Book Co., 1949. 2311 p. $17.00. (9th ed. in press.)

Le Grand, Rupert. *The New American Machinist's handbook*.
McGraw-Hill Book Co., 1955. 1572 p. $11.00.

Marks, Lionel S. *Mechanical engineers' handbook*. 5th ed.
McGraw-Hill Book Co., 1951. 2236 p. $16.50.

Oberg, Erik V. and F. D. Jones. *Machinery's handbook for machine shop and drafting room*.
15th ed. Holbrook L. Horton, editor. Industrial Press, 1954. 1911 p. $9.00.

O'Rourke, C. E. *General engineering handbook*. 2nd ed.
McGraw-Hill Book Co., 1940. 1120 p. $9.00.

Pender, Harold and others. *Electrical engineers' handbook*. 4th ed.
Electric power volume edited by Harold Pender and William Del Mar, 1949.
Communication—electronics volume edited by Harold Pender and Knox McIlwain, 1950.
John Wiley & Sons. 2 vols. $10.00 per vol.

Urquhart, Leonard C. *Civil engineering handbook*. 3rd ed.
McGraw-Hill Book Co., 1950. 1002 p. $11.00.

How to approach the problem

Adequate quick-reference material is essential in present-day design engineering. Many companies, recognizing this fact, have set up—or are in process of setting up—their own technical libraries. Most engineers have personal ones, but they may be badly out of date or otherwise inadequate.

Lists of recommended books have been compiled here to aid in the choice and acquisition of some of the best references in certain limited fields of interest. Their greatest value will be in calling unknown or unfamiliar titles to the attention of the reader and to guide the researcher to those books most likely to be of help in his work.

THE PERSONAL LIBRARY

Most engineering students acquire a total of around forty textbooks, weighing nearly 100 pounds, and now gathering dust on some six feet of bookshelf in office, attic or cellar. It is not surprising to count or weigh this four-year accumulation. What is disheartening is its lack of usefulness as a personal library. How often are these textbooks referred to for information or even as a memory jogger?

It is to be expected that books from which fundamentals are learned will be detailed and involved. Good reference books are terse, informative, comprehensive without excessive detail, practical rather than theoretical in approach, and usually well indexed.

Handbooks, then, provide the most value per dollar, and the most convenience per pound. They are written for the reader who is familiar with basic principles, but needs a reminder about the exact form of an equation, a screw thread or the tensile strength of a metal.

Some forty or fifty handbooks are available today ranging in price from $4.00 to nearly $20.00. It is encouraging to note that, while they are three to six times larger than the average text, their cost is comparable or at most double that of most technical books.

A selected list of handbooks for the designer is boxed at left. These twelve tomes are not all indispensable, but there is remarkably little duplication of information except in one or two cases covering the same field. In most, the coverage is broad rather than specialized, applied rather than theoretical, and references are usually included at the beginning or end of individual chapters for further study.

As a group these are probably the most valuable additions to a personal library; there is much to be said for having them within arm's reach. Minor questions may then be quickly answered when there is neither the time nor patience for library research. Therefore, an engineer's personal library, whether at home or office, should include many or all of these handbooks. Specialized texts may be added as need or interest dictates.

THE COMPANY LIBRARY

Few individuals need or can afford a more complete collection than that mentioned above. Libraries of 100 or more books are necessarily and properly the responsibility of the company. To be effective, even the smallest company library needs the organization that can be supplied only by an interested, enthusiastic and intelligent individual. Whether small or large, consisting of 100 books or 100,000, the services of a library extend far beyond the accumulation and cataloging of books, and a well organized library will pay for itself in convenience and research time many times over.

Just what are the proper functions of the company library? A library will acquire, classify, house and circulate books, periodicals, journals, government publications and manufacturers' catalogs. At its smallest it will contain 50 or 100 books and perhaps files of 20 or more of the most recent periodicals. Manufacturers' catalogs and literature may also be stored, and this is probably the messiest job of all to keep in reasonable order.

Someone already employed in the company can be held responsible for such a library—but a word of caution is in order here. Libraries grow at a fantastic rate. To be at all useful, they must be permitted to grow. When small, the entire collection can be taken in at a glance and cataloging and control may be kept to a minimum. Double the collection, and time and attention needed may be quadrupled. A card catalog becomes mandatory. Some sort of checking system is required to keep track of who has what. New purchases and periodical subscriptions must be kept up to date. These responsibilities are far beyond the capacities of the average employee, even full time. A trained librarian has taken a postgraduate course leading to the master's degree in library science to prepare for this job.

Starting a company library involves forethought as well as investment—more planning than money really. Without a plan and a proper librarian, the investment is wasted and the library an irritation rather than an aid.

Before starting a library, consult a trained librarian. The Special Libraries Association, 31 East 10 Street, New York 3, N. Y., can recommend a consultant in or near your city who will help in the critical planning stages, for a fee. This is probably the best investment that could be made at this stage.

A trained library consultant will choose a cataloging system best suited to the company needs, present and future. She will list the more important bibliographies and possibly set up a schedule for their eventual acquisition. She will estimate required shelf space, initiate interlibrary contacts, and help choose and train the company librarian. Best of all, having been instrumental in its birth, she will be naturally concerned with its progress. It is a real comfort to the inexperienced librarian to have expert and sympathetic advice no further away than the telephone.

As the library grows, the necessity for a full-time trained librarian becomes more urgent. Unfortunately the shortage of qualified librarians is quite as severe as the shortage of engineers. The Special Libraries Association maintains a placement service that may be helpful in this regard.

BOOKS

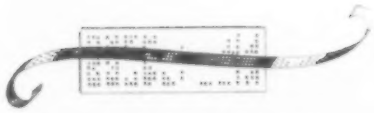
The trained librarian is not an engineer and can't be expected to have more than a general idea of the specific contents of the library. Staff members will know or can evaluate their own book needs from starter lists such as the one that follows. Once familiar with the company and its interests, the company librarian will be able to screen publishers' lists, book reviews and the various publications devoted to the announcement and review of new books. Staff advice on desirable acquisitions and an eye to the budget will then establish a book-order list.

Good bibliographies are difficult to compile, and a starter list must, of necessity, reflect the interest and opinions of the compiler. Because new books are published every day, no list is much better than last week's newspaper. Certain books, of course, have more long-term value than others. Handbooks should be included in a library of any size, and they can be expected to be of lasting value. Yet even handbooks are revised at frequent intervals, and it is wise to keep the library copy as recent as possible.

Certain classics in individual fields will retain their value indefinitely. Once a truly definitive work has been published, it will be referred to over and over again in the bibliographies and references of later works. Often major derivations or enunciations of principle are never completely repeated but altered or expanded upon by later authors. For these reasons some of the texts included in the accompanying starter list have publication dates 20 or 30 years old. However, where possible, latest editions were considered for inclusion first and earlier texts added only when it was felt inadvisable to omit them. Obviously final choice of a book is somewhat arbitrary and favorites are bound to be omitted, but the list is primarily intended to suggest titles which may be unfamiliar or forgotten.

All listed titles have been highly recommended either by publisher (for those not yet in print), technical librarian, or expert in the particular field. Where possible, latest editions and most recent prices have been listed although these are subject to change without notice.

Book list



AUTOMATIC CONTROL

American Society of Mechanical Engineers. *Automatic control terms.* ASME, 1954. 24 p. $1.50

Batcher, Ralph R. and William Moulic, *The electronic control handbook.* Caldwell-Clements, 1946. 344 p. $4.50

Berkeley, Edmund C. *Computers; their operation and applications.* Reinhold Publishing Corp., 1956. 376 p. . $8.00

Blackburn, John F. *Components handbook.* McGraw-Hill Book Co., 1948. 624 p. $8.00

Brown, G. S. and Donald P. Campbell, *Principles of servomechanisms:* dynamics and synthesis of closed-loop control systems. John Wiley & Sons, 1948. 400 p. $8.50

Chestnut, Harold and Robert W. Mayer. *Servomechanisms and regulating system design.* Vol. I: 1951, 505 p., $9.25. Vol. II: 1955, 384 p., $8.50 John Wiley & Sons.

Fett, Gilbert H. *Feedback control systems.* Prentice-Hall, 1954. 361 p. $8.50

Greenwood, I. A., J. V. Holdam, Jr., and Duncan MacRae, Jr. *Electronic instruments.* McGraw-Hill Book Co., 1948. 721 p. $10.00

Holzbock, Werner G. *Instruments for measurement and control.* Reinhold Publishing Corp., 1955. 416 p. $10.00

Jones, Richard W. *Electric control systems.* John Wiley & Sons, 1953. 511 p. $7.75

La Joy, Millard H. *Industrial Automatic Controls.* Prentice-Hall, 1954. 278 p. $7.00

Laning, J. Halcombe, Jr. and Richard H. Battin, *Random processes in automatic control.* McGraw-Hill Book Co., 1956. 429 p. $10.00

Lauer, Henri, Robert Lesnick and Leslie E. Matson. *Servomechanism fundamentals.* McGraw-Hill Book Co., 1947. 277 p. $5.50

Newton, G. C. *Analytical design of feedback controls.* John Wiley & Sons. In press.

Nixon, Floyd E. *Principles of automatic controls.* Prentice-Hall, 1953. 409 p. $7.50

Oldenbourg, R. C. and H. Sartorius. *Dynamics of automatic controls.* American Society of Mechanical Engineers, 1948, 276 p. $7.50

Rhodes, Thomas J. *Industrial instruments for measurement and control.* McGraw-Hill Book Co., 1941. 573 p. $7.50

Smith, E. S. *Automatic control engineering.* McGraw-Hill Book Co., 1944. 367 p. $5.50

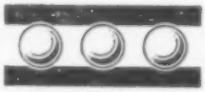
Soroka, Walter W. *Analog methods in computation and simulation.* McGraw-Hill Book Co., 1954. 390 p. $7.50

Thaler, George J., and Robert G. Brown. *Servomechanism analysis.* McGraw-Hill Book Co., 1953. 414 p. $8.00

Truxal, John G. *Automatic feedback control system synthesis.* McGraw-Hill Book Co., 1955. 695 p. . . $12.50

Tustin, A. *Direct current machines for control systems.* The Macmillan Co., 1952. 306 p. $10.00

West, John C. *Servomechanisms.* The Macmillan Co., 1954. 238 p. . . . $5.00



BEARINGS

Allan, Robert K. *Rolling bearings.* 2nd ed. Pitman Publishing Corp., 1946. 401 p. $8.50

Palmgren, Arvid. *Ball and roller bearing engineering.* SKF Industries, Inc., 1945. 270 p. $1.85

Shaw, Milton C., and Fred Macks. *Analysis and lubrication of bearings.* McGraw-Hill Book Co., 1949. 618 p. $10.00

Wilcock, D. F. and E. R. Booser. *Bearing design and application.* McGraw-Hill Book Co., 1957. 458 p. $12.50

CONSTRUCTION

American Society of Civil Engineers. Manuals of engineering practice. Coleman, H. S. *Laboratory design.* Reinhold Publishing Corp., 1951. 370 p. $15.00

Crane, Theodore. *Architectural construction; the choice of structural design.* John Wiley & Sons, 1956. 433 p. $10.00

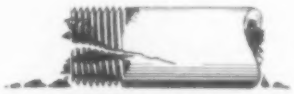
Dunham, Clarence W. *Planning industrial structures.* McGraw-Hill Book Co., 1948. 481 p. $8.00

Gibson, J. E. and D. W. Cooper. *The design of cylindrical shell roofs.* D. Van Nostrand Co., 1955. 186 p. $8.50

Jacoby, H. S. and R. P. Davis. *Foundations of bridges and buildings.* 3rd ed. McGraw-Hill Book Co., 1941. 535 p. $7.50

Peurifoy, R. L. *Construction planning, equipment and methods.* McGraw-Hill Book Co., 1956. 534 p. $8.50

Seelye, Elwyn E. *Data book for civil engineers:* vol. I: *Design.* 2nd ed. 1951. 521 p. $16.75. vol. II: Specifications and costs. 2nd ed. 1951. 506 p. $16.75. vol. III: *Field practice.* 2nd ed. 1954. 394 p. $7.50. John Wiley & Sons.



CORROSION

Burns, R. M. *Protective coatings for metals.* 2nd ed. Reinhold Publishing Corp., 1955. 657 p. . . . . $12.00 (ACS Monograph No. 129)

Evans, Ulick R. *Introduction to metallic corrosion.* St. Martin's Press, 1948. 211 p. $4.00

Evans, Ulick R. *Metallic corrosion, passivity and protection.* 2nd ed. St. Martin's Press, 1946. 863 p. Out of print.

Greathouse, Glenn A. and Carl J. Wessel. *Deterioration of materials; causes and preventive techniques.* Reinhold Publishing Corp., 1954. 850 p. $12.00

Rabald, E. *Corrosion Guide.* D. Van Nostrand Co., 1951. 630 p. . . . $14.00

Speller, Frank N. *Corrosion; causes and prevention.* 3rd ed. McGraw-Hill Book Co., 1951. 686 p. $11.00

Uhlig, Herbert H. *The corrosion handbook.* Sponsored by the Electrochemical Society. John Wiley & Sons, 1948. 1188 p. $15.00

DRAWING

French, Thomas E., and Charles J. Vierck. *A manual of engineering drawing for students and draftsmen.* 8th ed. McGraw-Hill Book Co., 1953. 715 p. $8.75

Hoelscher, Randolph P. and C. H. Springer. *Engineering drawing and geometry.* John Wiley & Sons, 1956. 520 p. $8.00

Ramsey, Charles G. and Harold R. Sleeper. *Architectural graphic standards.* 4th ed. John Wiley & Sons, 1951. 614 p. $15.00

Schumann, Charles H. *Descriptive geometry.* 4th ed. D. Van Nostrand Co., 1946. 338 p. $4.00

Turner, William W., Carson P. Buck and Hugh P. Ackert. *Basic engineering drawing;* a text integrating engineering drawing, descriptive geometry and machine drawing. The Ronald Press Co., 1950. 669 p. $5.50

ELECTRICAL

Abbott, Arthur L. *National electric code handbook.* 8th ed., McGraw-Hill Book Co., 1954. 642 p. $7.50

American Institute of Electrical Engineers. *American standard definitions of electrical terms.* AIEE, 1942. 311 p. $1.25

Dobie, W. B. and Peter Isaac. *Electric resistance strain gauges.* The Macmillan Co., 1949. 114 p. $4.00

Gray, Alexander and G. A. Wallace. *Principles and practice of electrical engineering.* 7th ed. McGraw-Hill Book Co., 1955. 598 p. $7.50

Johnson, Theron C., D. R. Shoults and C. S. Rife. *Electric motors in industry.* John Wiley & Sons, 1942. 389 p. $7.00

Lawrence, Ralph R. and Henry L. Richards. *Principles of alternating-current machinery.* 4th ed. McGraw-Hill Book Co., 1953. 623 p. $8.50

Still, Alfred, and Charles S. Siskind. *Elements of electrical machine design.* 3rd ed. McGraw-Hill Book Co., 1954. 445 p. $9.00

Ware, L. A. and George R. Town. *Electrical transients.* The Macmillan Co., 1954. 222 p. $4.75

ELECTRONICS

Albert, Arthur L. *Electronics and electron devices.* 3rd ed. The Macmillan Co., 1956. 576 p. $8.00

Annett, F. A. *Practical industrial electronics.* McGraw-Hill Book Co., 1952. 381 p. $6.00

Bendz, Waldemar I. *Electronics for industry.* John Wiley & Sons, 1947. 501 p. $7.00

Bevitt, William D. *Transistors handbook.* Prentice-Hall, 1956. 428 p. $9.00

Cage, John M. *Theory and application of industrial electronics.* McGraw-Hill Book Co., 1951. 209 p. $6.50

Cockrell, William D. *Indutsrial electronic control,* 2nd ed. McGraw-Hill Book Co., 1950. 385 p. $6.00

Corcoran, George F., and Henry W. Price. *Electronics.* John Wiley and Sons, 1954. 459 p. $7.00

Davis, Wells L. and Herman R. Weed. *Industrial electronic engineering.* Prentice-Hall, 1953. 514 p. $8.50

Happell, G. E. and W. M. Hesselberth. *Engineering electronics.* McGraw-Hill Book Co., 1953. 508 p. $8.00

Landee, Robert W., A. P. Albrecht and Donovan C. Davis. *Electronic designers' handbook.* McGraw-Hill Book Co. In press.

Lo, Arthur W. and others. *Transistor electronics.* Prentice-Hall, 1955. 400 p. $12.00

Richter, Walter. *Fundamentals of industrial electronic circuits.* McGraw-Hill Book Co., 1947. 569 p. $6.50

Terman, Frederick E. *Electronic and radio engineering.* 4th ed. McGraw-Hill Book Co., 1955. 1078 p. $12.50

Westinghouse Electric Corp. *Industrial electronics reference book.* John Wiley & Sons, 1948. 680 p. $14.00

FLUID MECHANICS

Binder, Ray C. *Advanced fluid dynamics and fluid machinery.* Prentice-Hall, 1951. 464 p. $6.00

Binder, Ray C. *Fluid mechanics.* 3rd ed. Prentice-Hall, 1955. 388 p. $7.65

Compressed Air and Gas Institute. *Compressed air handbook.* 2nd ed. McGraw-Hill Book Co., 1954. 468 p. $8.00

Cox, Glen and F. J. Germano. *Fluid mechanics.* D. Van Nostrand Co., 1941. 274 p. $4.50

Davis, Calvin V. *Handbook of applied hydraulics.* 2nd ed. McGraw-Hill Book Co., 1952. 1272 p. $15.00

Ellis, D. Stewart. *The elements of hydraulic engineering.* D. Van Nostrand Co., 1947. 277 p. $4.00

Ernst, Walter. *Oil hydraulic power and its industrial applications.* McGraw-Hill Book Co., 1949. 366 p. $8.00

Goldstein, Sydney. *Modern developments in fluid dynamics.* Oxford University Press, 1938. 2 vols. $13.45

Hadekel, Ruben. *Hydraulic systems and equipment.* Cambridge University Press, 1954. 224 p. $3.75

McClain, Clifford H. *Fluid flow in pipes.* The Industrial Press, 1952. 123 p. $3.00

Milne-Thomson, L. M. *Theoretical hydrodynamics.* 3rd ed. The Macmillan Co., 1956. 632 p. $9.80

Rouse, H. *Elementary mechanics of fluids.* John Wiley & Sons, Inc., 1946. 376 p. $5.50

Schlichting, Hermann. *Boundary layer theory.* McGraw-Hill Book Co., 1955. 535 p. $15.00

Schoder, Ernest W. and Francis M. Dawson. *Hydraulics.* 2nd ed. McGraw-Hill Book Co., 1934. 429 p. $7.00

Shapiro, A. H. *Dynamics and thermodynamics of compressible fluid flow.* The Ronald Press Co., 1953-1954. 2 vols. ..... $30.00 set

Stewart, Harry L. *Hydraulic and pneumatic power for production.* The Industrial Press, 1955. 416 p. $8.50

Streeter, Victor L. *Fluid dynamics.* McGraw-Hill Book Co., 1948. 263 p. $6.00

Streeter, Victor L. *Fluid mechanics.* McGraw-Hill Book Co., 1951. 366 p. $6.50

Vennard, John K. *Elementary fluid mechanics.* 3rd ed. John Wiley & Sons, 1954. 401 p. $5.50

GEARS

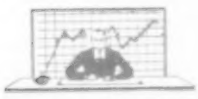
Buckingham, Earle. *Analytical mechanics of gears.* McGraw-Hill Book Co., 1949. 546 p. $10.00

Buckingham, Earle. *Manual of gear design.* Section 1: Mathematical tables, 1935, 183 p; Section 2: Spur and internal gears, 1935, 168 p; Section 3, Helical and spiral gears, 1937, 172 p. The Industrial Press, 3 Sections. Single section . . $3.50; set $9.00

Dudley, D. W. *Practical gear design.* McGraw-Hill Book Co., 1954. 335 p. $7.00

Merritt, H. E. *Gears.* 3rd ed. Pitman Publishing Corp., 1954. 527 p. $12.50

Page, Ray M. *14,000 gear ratios.* The Industrial Press, 1942. 400 p. . . $6.50



INDUSTRIAL MANAGEMENT

Alford, Leon P. and H. R. Beatly. *Principles of industrial management.* Rev. ed. The Ronald Press Co., 1951. 779 p. $6.75

American Society of Mechanical Engineers. *Small plant management.* E. H. Hempel, editor. McGraw-Hill Book Co., 1950. 499 p. $7.00

Bethel, Lawrence L., and others. *Essentials of industrial management.* McGraw-Hill Book Co., 1954. 449 p. $5.50

Carlson, Albert S. *Economic geography of industrial materials.* Reinhold Publishing Corp., 1956. 500 p. $12.50

Dean, J. *Managerial economics.* Prentice-Hall, 1951. 621 p. $6.50

Doyle, L. A. *Economics of business enterprise.* McGraw-Hill Book Co., 1952. 335 p. $5.50

Folts, Franklin E. *Introduction to industrial management.* 4th ed. McGraw-Hill Book Co., 1954. 684 p. $6.50

Grant, E. L. *Principles of engineering economy.* 3rd ed. The Ronald Press Co., 1950. 623 p. $6.75

MacNiece, E. H. *Production, forecasting, planning and control.* John Wiley & Sons, 1951. 305 p. $5.90

Moore, Franklin G. *Manufacturing management.* Richard D. Irwin, Inc. 1953. 832 p. $7.20

LUBRICATION

American Society of Lubrication Engineers. Publications on lubricants and friction.

American Society for Testing Materials. Committee D-2. *ASTM standards on petroleum products and lubricants.* ASTM Members, $4.85. ASTM, Annual. $6.50

Boner, C. J. *Manufacture and application of lubricating greases.* Reinhold Publishing Corp., 1954. 982 p. $18.50

Bowden and Tabor. *Friction and lubrication.* John Wiley & Sons, 1957. 150 p. $2.25

Brewer, Allen F. *Basic lubrication practice.* Reinhold Publishing Corp., 1955. 300 p. $6.75

Forbes, W. G., C. L. Pope and W. T. Everitt. *Lubrication of industrial and marine machinery.* 2nd ed. John Wiley & Sons, 1954. 351 p. $7.00

Fuller, D. D. *Theory and practice of lubrication for engineers.* John Wiley & Sons, 1956. 432 p. $10.50

Georgi, C. W. *Motor oils & engine lubrication.* Reinhold Publishing Corp., 1950. 514 p. Out of print.

Hobson, Paul D. *Industrial lubrication practice.* The Industrial Press, 1955. 534 p. $8.00

Norton, Arthur E. *Lubrication.* McGraw-Hill Book Co., 1942. 244 p. Out of print.

Slaymaker, R. R. *Bearing lubrication analysis.* John Wiley & Sons, 1955. 108 p. $5.00

Thomsen, Thomas C. *The practice of lubrication.* 4th ed. McGraw-Hill Book Co., 1951. 621 p. Out of print.

Zuidema, H. H. *Performance of lubricating oils.* Reinhold Publishing Corp., 1952. 250 p. $5.00. (ACS Monograph No. 113)

MATHEMATICS

Allendoerfer, C. B. and C. O. Oakley. *Principles of mathematics.* McGraw-Hill Book Co., 1955. 448 p. . . . $5.00

Andres, Paul G. and others. *Basic mathematics for science and engineering.* John Wiley & Sons, 1955. 846 p. $6.75

Beckenbach, Edwin F. *Modern mathematics for the engineer.* McGraw-Hill Book Co., 1956. 536 p. . . . $7.50

Davis, Dale S. *Nomography and empirical equations.* Reinhold Publishing Corp., 1955. 242 p. $6.75

Dull, Raymond and Richard Dull. *Mathematics for engineers.* 3rd ed. McGraw-Hill Book Co., 1951. 822 p. $8.50

Engineering Research Associates, Inc. staff. *High-speed computing devices.* W. W. Stifler, Jr., editor. McGraw-Hill Book Co., 1950. 440 p. . . . $7.00

Fry, Thornton C. *Probability and its engineering uses.* D. Van Nostrand Co., 1928. 483 p. $9.50

Grazda, Edward E. and Martin E. Jansson. *Handbook of applied mathematics.* 3rd ed. D. Van Nostrand Co., 1955. 1044 p. $7.95

Korn, Granino A. and Theresa M. Korn. *Electronic analog computers.* 2nd ed. McGraw-Hill Book Co., 1956. 464 p. $7.50

Oldenburger, Rufus. *Mathematical engineering analysis.* The Macmillan Co., 1951. 426 p. $8.00

Peirce, Benjamin O. *Short table of integrals.* 4th ed. Revised by R. M. Foster. Ginn and Co., 1956. 189 p. $2.25

Peters, J. *Seven-place values of trigonometric functions for every thousandth of a degree.* D. Van Nostrand Co., 1942. 370 p. $10.50

Reddick, Harry W. and F. H. Miller. *Advanced mathematics for engineers.* 3rd ed. John Wiley & Sons, 1955. 548 p. $6.50

Stibitz, G. R. and J. Larrivee. *Mathematics and computers.* McGraw-Hill Book Co., 1957. 234 p. $5.00

Von Vega, Baron. *Logarithmic tables of numbers and trigonometrical functions.* 84th ed. D. Van Nostrand Co., 603 p. $3.50

MECHANICS

Beggs, Joseph S. *Mechanism.* McGraw-Hill Book Co., 1955. 418 p. $7.50

Bevan, T. *The theory of machines.* 3rd ed. Longmans, Green & Co., 1956. 549 p. $5.00

Conway, Harry D. *Mechanics of materials.* Prentice-Hall, 1950. 325 p. $6.35

Den Hartog, J. P. *Mechanics.* McGraw-Hill Book Co., 1948. 462 p. $6.50

Doughtie, V. L. and W. H. James. *Elements of mechanism.* John Wiley & Sons, 1954. 494 p..... $6.00

Faires, Virgil M. *Design of machine elements.* 3rd ed. The Macmillan Co., 1955. 550 p..... $10.00

Gayer, John D. and Paul H. Stone, Jr. *Helical spring tables.* The Industrial Press, 1955. 165 p..... $5.00

Hinkle, R. T. *Kinematics of machines.* Prentice-Hall, 1953. 231 p..... $4.75

Housner, George W. and Donald E. Hudson. *Applied mechanics.* Vol I: *Statics,* 1949, 220 p., $4.00; Vol II: *Dynamics,* 1950, 295 p., $4.50. D. Van Nostrand Co., 2 vols.

Jones, Franklin D. and Holbrook L. Horton. *Ingenious mechanisms for designers and inventors.* Vol. 1, 1930, 536 p.; Vol. 2, 1936, 538 p.; Vol. 3, 1951, 536 p. The Industrial Press. Single vol. $6.50;..... set $16.00

Lindsay, Robert B. *Physical mechanics.* 2nd ed. D. Van Nostrand Co., 1950. 451 p..... $6.00

Mabie and Ocvirk. *Mechanisms and dynamics of machinery.* John Wiley & Sons, 1957. 440 p..... $7.50

Shigley, Joseph E. *Machine design.* McGraw-Hill Book Co., 1956. 523 p. $7.75

Sloane, Alvin. *Engineering kinematics.* The Macmillan Co., 1941. 310 p. $5.00

Spotts, M. F. *Design of machine elements.* 2nd ed. Prentice-Hall, 1953. 504 p. $7.25

Timoshenko, Stephen and D. H. Young. *Advanced dynamics.* McGraw-Hill Book Co., 1948. 400 p. $8.50

METALS

Abkowitz, Stanley, John J. Burke, and Ralph H. Hiltz, Jr. *Titanium in industry.* D. Van Nostrand Co., 1955. 224 p. $5.00

American Society for Metals. *Metals handbook,* 1948 edition. Edited by Taylor Lyman. The American Society for Metals, 1948. 1332 p. $15.00. 1954 Supplement, 184 p., $6.00; 1955 Supplement, 208 p..... $6.00

Bray, John L. *Ferrous process metallurgy.* John Wiley & Sons, 1954. 414 p. $6.50

Bray, John L. *Non-ferrous production metallurgy.* 2nd ed. John Wiley & Sons, 1947. 587 p..... $6.00

Bullens, D. K. and Metallurgical Staff of Battelle Memorial Institute. *Steel and its heat treatment.* 5th ed. Vol 1: *Principles,* 1948, 489 p., $8.75; Vol 2: *Tools, processes, control,* 1948, 293 p., $5.50; Vol 3: *Engineering and special-purpose steels,* 1949, 607 p., $9.50. John Wiley & Sons.

Camp, James M. and C. B. Francis. *The making, shaping and treating of steel.* 6th ed. United States Steel Co., 1951. 1584 p..... $7.50

Carpenter, Sir Henry C. H. and J. Robertson. *Metals.* Oxford University Press, 1939. 2 vols... $16.80 per vol.

Clark, Donald S. and Wilbur R. Varney. *Physical metallurgy for engineers.* D. Van Nostrand, 1952. 567 p. $6.50

Clark, Frances H. *Metals at high temperatures.* Reinhold Publishing Corp., 1950. 394 p..... $8.50

Conway, C. G. *Heat-resisting steels and alloys.* D. Van Nostrand Co., 1953. 160 p..... $5.00

Doan, Gilbert E. *Principles of physical metallurgy.* 3rd ed. McGraw-Hill Book Co., 1953. 318 p..... $6.50

Du Mond, T. C. *Engineering materials manual.* Reinhold Publishing Corp., 1951. 386 p..... $6.50

Everhart, John L. *Titanium and titanium alloys.* Reinhold Publishing Corp., 1954. 189 p..... $2.95

Hampel, Clifford A. *Rare metals handbook.* Reinhold Publishing Corp., 1954. 544 p..... $12.00

Hayward, Carle R. *Outline of metallurgical practice.* 3rd ed. D. Van Nostrand Co., 1952. 728 p.... $11.50

Henderson, J. G., assisted by J. M. Bates. *Metallurgical dictionary.* Reinhold Publishing Corp., 1953. 408 p. $8.50

Heyer, Robert H. *Engineering physical metallurgy.* D. Van Nostrand Co., 1939. 549 p..... $6.00

Hoyt, Samuel L. *Metal Data.* Revised edition of *Metals and Alloys Data Book.* Reinhold Publishing Corp., 1952. 526 p..... $12.00

Miner, Douglas F. and John B. Seastone. *Handbook of engineering materials.* 1st ed. John Wiley & Sons, 1955. 1382 p. $17.50

Mondolfo, L. F. and Otto Zmeskal. *Engineering metallurgy.* McGraw-Hill Book Co., 1955. 382 p..... $8.00

Moore, Herbert F. and Mark B. Moore. *Textbook of the materials of engineering.* 8th ed. McGraw-Hill Book Co., 1953. 372 p..... $6.50

Pagonis, George A. *The light metals handbook.* D. Van Nostrand Co., 1954. 2 vols..... $9.50 set

Polushkin, E. P. *Defects and failures of metals.* D. Van Nostrand Co., 1956. 399 p..... $12.50

Samans, Carl H. *The engineering metals and their alloys.* The Macmillan Co., 1948. 913 p..... $10.75

Schwarzkopf, Paul and Richard Kieffer. *Refractory hard metals.* The Macmillan Co., 1953. 447 p... $10.00

Sisco, Frank T. *Modern metallurgy for engineers.* 2nd ed. Pitman Publishing Corp., 1948. 499 p..... $6.00

Smithells, Colin J. *Metals reference book.* 2nd rev. ed. Interscience Publishers, 1955. 2 vols... $12.50 per vol.

Udy, Marvin J. *Chromium.* Reinhold Publishing Corp., 1956. 2 vols. $11.00 per vol. (ACS monograph No. 132).

White, Alfred H. *Engineering Materials.* 2nd ed. McGraw-Hill Book Co., 1948. 686 p..... $8.00

Woldman, Norman E. *Materials engineering of metal products.* Reinhold Publishing Corp., 1949. 580 p. $11.00

Zeerleder, A. Von. *Technology of light metals.* 3rd ed. D. Van Nostrand Co., 1949. 366 p..... $8.00

NUCLEAR

Beck, Clifford K. *Nuclear reactors for research.* D. Van Nostrand Co., 1957. In Press. 352 p..... $8.50

Glasstone, Samuel. *Sourcebook on atomic energy.* John Wiley & Sons, 1950. 562 p..... $3.75

Hausner, Henry H. and Stanley B. Roboff. *Materials for nuclear power reactors.* Reinhold Publishing Corp., 1955. 240 p..... $3.50

Kaplan, Irving. *Nuclear physics.* Addison-Wesley Publishing Co., 1955. 609 p. $8.50

Rockwell, Theodore, III. *Reactor shielding design manual.* D. Van Nostrand Co., 1956. 480 p..... $6.00

Schultz, M. A. *Control of nuclear reactors and power plants.* McGraw-Hill Book Co., 1955. 313 p..... $7.50

Stephenson, Richard. *Introduction to nuclear engineering.* McGraw-Hill Book Co., 1954. 387 p..... $8.00

U. S. Atomic Energy Commission. *Reactor handbook; engineering.* McGraw-Hill Book Co., 1955. 1088 p. $15.00

U. S. Atomic Energy Commission. *Reactor handbook: materials.* McGraw-Hill Book Co., 1955. 614 p. $10.50

U. S. Atomic Energy Commission. *Research reactors.* McGraw-Hill Book Co., 1955. 460 p.....$6.50

PLASTICS

American Society for Testing Materials. Committee D-20. *ASTM standards on plastics.* ASTM, 1955. 790 p. $5.75; ASTM Members, $4.40

Barron, Harry. *Modern plastics.* John Wiley & Sons, 1945. 680 p. Out of print.

Bjorksten, Johan, and others. *Polyesters and their applications.* Reinhold Publishing Corp., 1956. 626 p. $10.00

Brown, Derek Warburton. *Handbook of engineering plastics.* George Newnes, Ltd., 1943. 216 p. Out of print.

Davis, Robert L. and Ronald D. Beck. *Applied plastic product design.* Prentice-Hall, 1946. 285 p. Out of print.

Delmonte, John. *Plastics molding.* John Wiley & Sons, 1952. 493 p. $10.00

Fleck, Harry R. *Plastics manual.* English Universities Press, 1947. 155 p. .....15 Shillings.

Mark, H., E. S. Proskauer and V. J. Frilette. *Resins, rubbers and plastics yearbook, 1955.* Interscience Publishers, 1956. 1148 p.....$35.00

Mark, Hermann F. and E. S. Proskauer. *The science of plastics.* A comprehensive source book based on the original literature for 1942-46. Interscience Publishers, 1948. 632 p. $7.50

Sasso, John. *Plastics handbook for product engineers.* McGraw-Hill Book Co., 1946. 468 p. Out of print.

Seymour, Raymond B. and Robert H. Steiner. *Plastics for corrosion-resistant applications.* Reinhold Publishing Corp., 1955. 449 p.....$7.50

Simonds, Herbert R. *Industrial Plastics.* 3rd ed. Pitman Publishing Corp., 1945. 369 p.....$6.00

Simonds, Herbert R., A. J. Weith and M. H. Bigelow. 2nd ed. *Handbook of plastics.* D. Van Nostrand Co., 1949. 1511 p. $25.00

Society of the Plastics Industry, Inc. *SPI plastics engineering handbook.* Second edition of *SPI handbook.* Reinhold Publishing Corp., 1954. 850 p. $15.00

Winding, Charles C. and R. Leonard Hasche. *Plastics, theory and practice; the technology of high polymers.* McGraw-Hill Book Co., 1947. 280 p. $6.00

PRODUCTION

Alford, L. P. and J. R. Bangs. *Production handbook.* The Ronald Press Co., 1944. 1676 p. $12.00

American Society of Tool Engineers. *Die design handbook.* Frank W. Wilson, editor-in-chief. McGraw-Hill Book Co., 1955. 732 p.....$14.50

American Society of Tool Engineers. *Tool engineers handbook.* Frank W. Wilson, editor-in-chief. McGraw-Hill Book Co., 1949. 2005 p.....$15.00

Begeman, Myron L. *Manufacturing processes.* 3rd ed. John Wiley & Sons, 1952. 608 p.....$6.50

Bolz, Roger W. *Production processes; their influence on design.* Penton Publishing Co., 1949-1951. 2 vols. $15.00 a set.

Buckingham, Earle. *Dimensions and tolerances for mass production.* The Industrial Press, 1954. 164 p...$8.00

Doyle, Lawrence E. *Metal machining.* Prentice-Hall, 1953. 511 p.....$7.50

Doyle, Lawrence E. *Tool engineering: analysis and procedure.* Prentice-Hall, 1950. 499 p.....$8.65

Hesse, Herman C. *Engineering tools and processes.* D. Van Nostrand Co., 1941. 627 p.....$7.00

Jones, Franklin D. *Jig and fixture design.* 4th ed. The Industrial Press, 1955. 406 p.....$5.00

Laughner, Vallory H. and Augustus D. Hargan. *Handbook of fastening and joining metal parts.* McGraw-Hill Book Co., 1956. 656 p.....$15.00

Lytle, Charles W. and Arthur F. Gould. *Manufacturing equipment and processes.* 3rd ed. International Textbook Co., 1951. 759 p. Out of print.

Metal Cutting Tool Institute. *Metal cutting tool handbook.* Rev. ed. Metal Cutting Tool Institute, 1954. 689 p. $7.50

Morris, Joe L. *Modern manufacturing processes.* Prentice-Hall, 1955. 566 p. $7.00

Morrow, L. C. *Maintenance engineering handbook.* McGraw-Hill Book Co., 1957. 1156 p. In Press.

Riley, Malcolm W. *Plastics tooling.* Reinhold Publishing Corp., 1955. ... 133 p. $2.50

Schaller, Gilbert S. *Engineering manufacturing methods.* McGraw-Hill Book Co., 1953. 607 p.....$7.00

Staniar, William. *Plant engineering handbook.* McGraw-Hill Book Co., 1950. 2007 p.....$17.00

Thompson, T. G. and R. A. Peterson. *Illustrated jig-tooling dictionary.* The Macmillan Co., 1947. 349 p....$1.95

Wagener, Albert M. and Harlan R. Arthur. *Machine shop; theory and practice* . 2nd ed. D. Van Nostrand Co., 1950. 306 p.....$4.50

Wagener, Albert M. and Harlan R. Arthur. *The machinists' and draftsmen's handbook.* D. Van Nostrand Co., 1945. 662 p.....$6.95

Woldman, Norman E. and Robert C. Gibbons. *Machinability and machining of metals.* McGraw-Hill Book Co., 1951. 198 p.....$8.00

Young, James F. *Materials and processes.* 2nd ed. John Wiley and Sons, 1954. 1074 p.....$9.75

STRENGTH OF MATERIALS

Battelle Memorial Institute. *Prevention of the failure of metals under repeated stress.* John Wiley & Sons, 1941. 273 p. Out of print.

Den Hartog, Jacob P. *Advanced strength of materials.* McGraw-Hill Book Co., 1952. 379 p.....$8.50

Hetenyi, M. and Walter P. Murphy. *Handbook of experimental stress analysis.* John Wiley & Sons, 1950. 1077 p. $15.00

Laurson, Philip G. and William J. Cox. *Mechanics of Materials.* 3rd ed. John Wiley & Sons, 1954. 414 p.....$5.75

Morley, A. *Strength of materials.* 11th ed. Longmans, Green & Co., 1954. .....$5.00

Muhlenbruch, Carl. *Experimental mechanics and properties of materials.* 2nd ed. D. Van Nostrand Co., 1955. 243 p. $3.00

Osgood, W. R. *Residual stresses in metals and metal construction.* Reinhold Publishing Corp., 1954. 375 p. $10.00

Phillips, A. *Introduction to plasticity.* The Ronald Press Co., 1956....$7.00

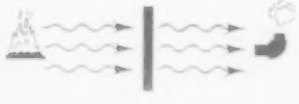
Popov, Egor P. *Mechanics of materials.* Prentice-Hall, 1952. 441 p. $6.75

Roark, Raymond J. *Formulas for stress and strain.* 3rd ed. McGraw-Hill Book Co., 1954. 381 p. $7.50

Seely, Fred B. and James O. Smith. *Advanced Mechanics of materials.* 2nd ed. John Wiley and Sons, 1952. 680 p. $8.50

Timoshenko, Stephen. *Strength of materials.* 3rd ed. Part I: *Elementary theory and problems,* 1955, 434 p., $6.50; Part II: *Advanced theory and problems,* 1956, 572 p., $7.50. D. Van Nostrand Co. 2 vols.

Timoshenko, S. and J. N. Goodier. *Theory of Elasticity.* 2nd ed. McGraw-Hill Book Co., 1951. 506 p. $10.00



THERMODYNAMICS AND HEAT TRANSFER

Adams, Arthur S. and George D. Hilding. *Fundamentals of thermodynamics.* Harper & Brothers, 1945. 289 p. Out of print.

Brown, Audrey I. and Salvatore M. Marco. *Introduction to heat transfer.* 2nd ed. McGraw-Hill Book Co., 1951. 266 p. $5.50

De Groot, S. R. *Thermodynamics of irreversible processes.* Interscience Publishers, 1951. 242 p. $5.50

Fishenden, M. and O. A. Saunders. *An introduction to heat transfer.* Oxford University Press, 1950. 205 p. $3.40

Guggenheim, E. A. *Thermodynamics.* Interscience Publishers, 1949. 419 p. $6.50

Hutchinson, F. W. *Industrial heat transfer.* The Industrial Press, 1952. 336 p. $6.00

Ingersoll, Leonard R., O. J. Zobel and A. C. Ingersoll. *Heat conduction, with engineering, geological, and other applications.* Rev. ed. University of Wisconsin Press, 1954. 340 p. . .$5.00

Jakob, M. *Heat transfer:* Vol 1. John Wiley & Sons, 1949. 758 p. . . .$12.00

Jakob, M. and G. A. Hawkins. *Elements of heat transfer and insulation.* 2nd ed. John Wiley & Sons, 1950. 230 p. $4.50

Keenan, Joseph H. and Frederick G. Keyes. *Thermodynamic properties of steam,* including data for the liquid and solid phases. John Wiley & Sons, 1936. 89 p. $5.00

Keenan, Joseph H. and Joseph Kaye. *Gas tables;* thermodynamic properties of air, products of combustion and component gases; compressible flow functions including those of Ascher H. Shapiro and Gilbert M. Edelman. John Wiley & Sons, 1948. 238 p. $6.00

Keenan, Joseph H. *Thermodynamics.* John Wiley & Sons, 1941. 499 p. $6.50

Kiefer, Paul J., G. F. Kinney and M. C. Stuart. *Principles of engineering thermodynamics.* 2nd ed. John Wiley and Sons, 1954. 539 p. . .$7.75

Lee, John F. and Francis W. Sears. *Thermodynamics.* Addison-Wesley Publishing Co., 1955. 500 p. . . .$8.50

McAdams, William H. *Heat Transmission.* 3rd ed. McGraw-Hill Book Co., 1954. 490 p. $9.00

Mooney, David A. *Mechanical engineering thermodynamics.* Prentice-Hall, 1953. 540 p. $7.50

Moyer, James A., J. P. Calderwood and A. A. Potter. *Elements of engineering thermodynamics.* 6th ed. John Wiley & Sons, 1941. 217 p. $4.00

Schneider, Paul J. *Conduction heat transfer.* Addison-Wesley Publishing Co., 1955. 408 p. $10.50

Stoever, Herman J. *Applied heat transmission.* McGraw-Hill Book Co., 1941. 226 p. $4.50

Zemansky, Mark W. *Heat and thermodynamics.* 4th ed. McGraw-Hill Book Co., 1957. 496 p. $7.50

TRANSPORT

Bisplinghoff, R. L., H. Ashley, and R. L. Halfman. *Aeroelasticity.* Addison-Wesley Publishing Co., 1955. 860 p. $14:50

Bonney, E. Arthur. *Engineering supersonic aerodynamics.* McGraw-Hill Book Co., 1950. 264 p. $6.50

Diehl, W. S. *Engineering aerodynamics.* Rev. ed. The Ronald Press Co., 1936. 556 p. $7.00

Heldt, Peter M. *High-speed combustion engines.* 16th ed. Chilton Co., 1956. 805 p. $12.00

Heldt, Peter M. *High-speed diesel engines.* 7th ed. Chilton Co., 1953. 472 p. $7.50

Lichty, Lester C. *Internal combustion engines.* 6th ed. McGraw-Hill Book Co., 1951. 583 p. $7.50

Liepmann, Hans W. and Allen E. Puckett. *Introduction to aerodynamics of a compressible fluid.* John Wiley & Sons, 1947. 262 p. $5.50

Liston, Joseph. *Powerplants for aircraft.* McGraw-Hill Book Co., 1953. 577 p. $9.00

Millikan, C. B. *Aerodynamics of the airplane.* John Wiley & Sons, 1941. 171 p. $5.00

Milne-Thomson, L. M. *Theoretical aerodynamics.* 2nd ed. D. Van Nostrand Co., 1952. 414 p. $10.00

Obert, E. F. *Internal combustion engines.* 2nd ed. International Textbook Co., 1950. 614 p. $8.50

Perkins, Courtland D., and Robert E. Hage. *Airplane performance, stability and control.* John Wiley & Sons, 1949. 493 p. $7.00

Prandtl, L. and O. G. Tietjens. *Fundamentals of hydro- and aeromechanics.* Dover. In Press.

Pye, D. R. *The internal combustion engine.* Vol. 1: *Principles.* 2nd ed. 309 p. 1937. $4.80. Vol. 2: *The aero-engine,* 1934. 398 p. $5.60. Oxford University Press.

Ricardo, Harry R. *High speed internal combustion engine.* 4th ed. Robert Bentley, Inc., 1953. 420 p. . . .$11.00

Rossell, Henry E. and Lawrence B. Chapman. *Principles of naval architecture.* The Society of Naval Architects and Marine Engineers, 1939. 2 vols. $11.00 a set; $6.00 per vol. (Rev. ed. in preparation)

Rossini, Frederick D. *Thermodynamics and physics of matter.* Princeton University Press, 1955. 832 p. $15.00

Seward, Herbert L. *Marine engineering.* The Society of Naval Architects and Marine Engineers, 1942-44. 2 vols. $11.00 a set; $6.00 per vol.

Taylor, C. F. and E. S. Taylor. *The internal combustion engine.* Rev. ed. International Textbook Co., 1948. 322 p. $6.75

Wood, Karl D. *Technical aerodynamics.* 3rd ed. The Author, 1955. 504 p. $7.50. Distributed by Ulrich's Book Store, 549 E. University Ave., Ann Arbor, Mich.

Von Mises, Richard. *Theory of flight.* McGraw-Hill Book Co., 1945. 629 p. $9.00

Zucrow, M. J. *Principles of jet propulsion.* John Wiley & Sons, 1948. 563 p. $8.00

VIBRATION

Cole, E. B. *Theory of vibration for engineers.* 2nd ed. The Macmillan Co., 1952. 334 p. $4.00

Crandall, Irving B. *Theory of vibrating systems and sound.* D. Van Nostrand Co., 1927. 282 p. $5.50

Crede, Charles E. *Vibration and shock isolation.* John Wiley & Sons, 1951. 328 p. $8.00

Freberg, C. R. and E. N. Kemler. *Elements of mechanical vibration.* 2nd ed. John Wiley & Sons, 1949. 227 p. $4.50

Hansen, H. M. and P. F. Chenea. *Mechanics of vibration.* John Wiley & Sons, 1952. 417 p. $8.00

Morse, Philip M. *Vibration and sound.* 2nd ed. McGraw-Hill Book Co., 1948. 487 p. $7.00

Myklestad, N. *Fundamentals of vibration analysis.* McGraw-Hill Book Co., 1956. 260 p. $6.50

Olson, Harry F. *Elements of acoustical engineering.* 2nd ed. D. Van Nostrand Co., 1947. 537 p. $7.50. (3rd ed. in Press)

Richardson, E. G. *Technical aspects of sound.* Vol. 2: Ultrasonic range, underwater acoustics and aircraft noise. D. Van Nostrand Co., 1956. 600 p. $11.75

Swenson, George W., Jr. *Principles of modern acoustics.* D. Van Nostrand Co., 1953. 222 p. $4.00

Thomson, William T. *Mechanical vibration.* 2nd ed. Prentice-Hall, 1953. 252 p. $4.75

Timoshenko, Stephen. *Vibration problems in engineering.* 3rd ed. D Van Nostrand Co., 1955. 468 p. $8.75

Wilson, William K. *Practical solution of torsional vibration problems,* Vol. 1. 3rd ed. John Wiley & Sons, 1956. 704 p. $16.00

Zwikker, C. and C. W. Kosten. *Sound absorbing materials.* D. Van Nostrand Co., 1949. 174 p. $4.00

Bibliographies

Certainly not all eight bibliographies listed below need be purchased, particularly for a small starting library. However, at least one, *Books in Print,* can be very helpful when a title or author is known without the vital information about publisher, date of publication and cost. Others may be purchased as the need arises and really large libararies will have them all.

One of the major duties of any librarian is to be aware of new books and periodicals so that her library will not lack an important work. To this end she will spend time reading book reviews in the many periodicals, publishers' lists, Special Libraries Association publications and many other new-book announcements.

The *Techical Book Review Index* is convenient for this purpose. It is an up-to-date listing of newly published books and includes abstracts of book reviews from technical journals. These are invaluable in informing the librarian about what has been published, its content and approximate value to the company.

Books in print. R. R. Bowker Co., annual. $19.00. Divided into two parts listing books alphabetically by author and by title.

Cumulative book index; a world list of books in the English language. The H. W. Wilson Co., monthly, with bound cumulations. $28.00 per year. Author, title, and subject catalog of published books.

Dalton, Blanche H. *Sources of engineering information.* University of California Press, 1949. 109 p. $4.00. A handbook and bibliography of source material in all branches of engineering.

Hawkins, R. R. *Scientific, medical and technical books published in the United States of America,* 1930-1944, with supplements, 1945-1948 and 1949-1952. R. R. Bowker Co. 3 vols. $20.00; $10.00; $10.00. Contents and brief reviews.

Roberts, A. D. *Guide to technical literaure.* Grafton & Co., 1939. 279 p. Out of print.

Special Libraries Association. *Bibliography of engineering abstracting services.* S.L.A., 1955. 37 p. $1.50. (S.L.A. Bibliography No. 1)

Special Libraries Association. *Technical book review index.* S.L.A., ten issues a year. $7.50. Brief extracts of book reviews appearing in the technical press.

Winchell, Constance M. and O. A. Johnson. *Guide to reference books.* 7th ed. American Library Association, 1951. 645 p. $10.00. Supplement, 1950-1952, published 1954. 117 p. $3.25.

Biographical references

Often a problem will require an expert consultant rather than published information. Perhaps more detailed data are needed than appeared in a particular paper or book. One convenient source of biographical information is a membership list of the applicable technical society. Most engineers are members of at least one (and probably more than one) society and the societies regularly distribute lists of names and addresses of their members.

Cattell, Jacques. *American men of science*. 9th ed. 3 Vols. Vol. 1: Physical sciences. R. R. Bowker Co., 1955. 2180 p. $20.00.

Downs, W. S. and Edward N. Dodge, *Who's Who in engineering*. 7th ed. Lewis Historical Publishing Co., 1954. 2861 p. $17.50.

Firth, Margaret A. *Handbook of scientific and technical awards in the United States and Canada*, 1900-1952. Special Libraries Association, 1956. 491 p. $10.00.

Technical societies membership lists. A comprehensive listing of *Membership Directories of American Scientific and Engineering Societies* by Harry R. Skallerup, appeared in *Special Libraries*, V. 48, No. 1, p. 12-18, Jan. 1957.

General library reference

Certain general reference books are indispensable to the proper operation of a library. If there is an unabridged dictionary anywhere in the company, put it in the library. Put it on a high table for easy access when standing and leave enough room so that it may be opened and left that way. Nothing discourages dictionary use so much as the need to carry it to a table across the room and back again.

A comprehensive encyclopedia like the *Americana* or *Britannica* is a natural and very worthwhile addition to the collection. Several other dictionaries and general reference books are listed below.

Special attention should be given to Lucille Jackson's *Technical Libraries*. This is the best available work on the organization and management of technical libraries.

Bartlett, John. *Familiar quotations*. 13th ed. Little, Brown and Co., 1955. 1614 p. $10.00.

Bridgwater, W. and E. J. Sherwood, *Columbia encyclopedia*. 2nd ed. Columbia University Press, 1950, with 1953 supplement. 2227 p. $35.00.

Brown, V. J. and D. G. Runner, *Engineering terminology*. 2nd ed. Gillette Publishing Co., 1939. 439 p. Out of print.

Encyclopedia Britannica or *The Encyclopedia Americana*.

Fowler, H. W. *Dictionary of modern English usage*. Oxford University Press, 1937. 742 p. $3.75.

Jackson, Lucille. *Technical libraries; their organization and management*. Special Libraries Association, 1951. 202 p. $6.00.

James, G. and R. C. James, *Mathematics dictionary*. D. Van Nostrand Co., 1949. 432 p. $10.00.

Jones, F. D. *Engineering encyclopedia*. 2nd ed. Industrial Press, 1954. 2 vols. 1432 p. $10.00.

Standards issued by the technical societies and government bureaus.

Tweney, C. F. and L. E. C. Hughes, *Chambers's technical dictionary*. Macmillan Co., 1944. 975 p. $6.50.

Unabridged Dictionary.

Van Nostrand's scientific encyclopedia. 2nd ed. D. Van Nostrand Co., 1947. 1600 p. $20.00.

The world almanac and book of facts. New York World-Telegram and Sun. annual. $2.10.

World Atlas.

Periodicals

Society publications that appear regularly, trade journals, magazines and house organs pour into the mails in an unending stream. It is virtually impossible for any one individual to read or even scan the publications in all of these fields, yet a professional cannot ignore this flood. New developments, theories and experimental data appear in periodicals long before they are made available in book form, and often this is the only place they ever will appear.

Many companies have set up involved abstracting or distribution systems to limit reading time to a minimum without blocking the flow of information to the staff. The problem then shifts to the need for a well-informed individual who can screen and direct the incoming information to the proper staff member.

A librarian, particularly one having some science training, can handle this job, but if it is an added burden to her other responsibilities she will soon fall behind in this monumental task and the whole system will collapse. No one solution to this problem is applicable to all companies. Most engineers will subscribe to and read two or three or more trade and society publications in any case. For more extensive surveys, one of the abstracting services mentioned below should be considered.

In most libraries, periodicals are kept on shelves in alphabetical order by title. Often only the issues of the past year or two are kept because space is filled at an alarming rate by these publications. For example, twelve issues of *Product Engineering*, plus the *Design Digest Issue*, will make a stack 10 in. high that will grow at a rate of ¾ in. per month.

Some libraries are charged with the responsibility of maintaining all company subscriptions and routing them to the proper individuals. Others maintain only their own subscriptions, recording receipt of each issue and charging them out and in as they are used by staff members.

MANUFACTURER'S PUBLICATIONS

Allis-Chalmers Electrical Review
Bell Laboratories Record
Bell System Technical Journal
Electrical Communication (IT & T)
The Engineer (Western Electric)
General Electric Review
General Motors Engineering Journal
IBM Journal of Research and Development
Instrumentation (Minneapolis-Honeywell)
Lubrication (The Texas Co.)
Magazine of Magnesium (Brooks and Perkins)
Philips Technical Review (Philips Research Labs)
Reynolds Aluminum Digest
Sperryscope
Sylvania Technologist
Systems (Sperry Rand)
Westinghouse Engineer

TRADE PERODICALS

Aero Digest
Aircraft Production
American Machinist
American Metal Market
Applied Hydraulics
Automatic Control
Automation
Automotive Industries
Aviation Week
Business Week
Chemical Engineering
Chemical Engineering Progress
Chemical Week
Coal Age
Commercial Car Journal
Construction Methods and Equipment
Consulting Engineer
Control Engineering
Design News
Electric Light and Power
Electrical Construction and Maintenance
Electrical Manufacturing
Electrical World
Electronic Industries & Tele-Tech
Electronic Week
Electronics
Engineer
Engineering
Engineering and Mining Journal
Engineering News-Record
Factory Management and Maintenance
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Industry Power
Instruments and Automation
Iron Age
Light Metal Age
Machine Design

Machinery
Management Digest
Marine Engineer and Naval Architect
Mass Production
Materials & Methods
Mechanical World and Engineering Record
Metal Industry
Metals (Supplement to Daily Metal Reporter)
Metalworking Production
Mill and Factory
Mining Journal
Modern Machine Shop
Modern Metals
Modern Packaging
Modern Plastics
Modern Power and Engineering
National Petroleum News
Newsweek
Nucleonics
Oil and Gas Journal
Packaging Review
Petroleum Engineer
Petroleum Processing
Petroleum Week
Plant Engineering
Plastics Technology
Plastics World
Power
Power Engineering
Precision Metal Molding
Product Engineering
Scientific American
Sheet Metal Industries
Steel
Textile World
Welding Engineer

SOCIETY, UNIVERSITY, AND GOVERNMENT PUBLICATIONS

Acoustical Society of America, Journal
Advanced Management
Aeronautical Engineering Review
Aeronautical Quarterly
Aircraft Engineering
American Institute of Electrical Engineers, Transactions
American Institute of Mining, Metallurgical, and Petroleum Engineers, Transactions
American Management Association publications
American Society for Metals, Transactions
American Society for Testing Materials, Bulletin, Proceedings
American Society of Civil Engineers, Proceedings, Transactions
American Society of Mechanical Engineers, Transactions
American Society of Naval Engineers, Journal
Applications and Industry
Applied Mechanics Reviews
Bureau of Ships Journal
Civil Engineering
Communication and Electronics
Compressed Air Magazine
Corrosion
Electrical Engineering
Electrochemical Society, Journal
Electronic Engineering
Engineering Journal
Gray Iron News
Industrial Quality Control
Institute of Marine Engineers, Transactions
Institute of Radio Engineers, Proceedings
Institution of Electrical Engineers, Proceedings
Institution of Mechanical Engineers, Proceedings
Institution of Mining and Metallurgy, Bulletin
Institution of Production Engineers, Journal
Instrument Society of America, Journal
Iron and Steel Engineer
Iron and Steel Institute, Journal
Jet Propulsion
Journal of the Aeronautical Sciences
Journal of Applied Mechanics
Journal of Applied Physics
Journal of Engineering Education
Journal of Metals
Journal of Research of the National Bureau of Standards
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Metals Review
Mining Engineering
Modern Castings (formerly American Foundryman)
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Plating
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Research Reviews, Office of Naval Research
Review of Scientific Instruments
Scientific Monthly
Society of Automotive Engineers, Journal, Transactions
Society of Plastics Engineers, Journal
Tool Engineer
Welding Journal

Indexes

Two major abstracting and indexing services are available for extensive coverage of the technical literature. *The Engineering Index,* published by Engineering Index, Inc., 29 West 39th Street, New York 18, N. Y., abstracts important articles from some 1200 periodicals and 300 books yearly in all languages. These are printed on standard library-sized cards and then mailed weekly to subscribers.

Three hundred divisions comprise the subject coverage and may be subscribed to individually or in groups. Division subscriptions vary in cost from $10.00 to $45.00 per year. The complete service turns out about 25,000 cards annually and is available at a special rate. An annual volume is also available.

The Industrial Arts Index is published by H. W. Wilson Co., 950 University Ave., New York 52, N. Y., and limits its service to a subject index of articles in over 200 engineering, trade, and business periodicals. This index is issued monthly and cumulated quarterly and annually.

Manufacturers catalogs & bulletins

Whether it has a formal library or not, every manufacturing company large or small must include provisions for the acquisition, storage and dissemination of manufacturers' catalogs and bulletins. Purchased items often make up a large percentage of the final assembled product, and speedy design depends on the availability of detailed information about raw material, fasteners and other mechanical and electrical parts.

Manufacturers' literature is obtained by letterhead request usually in response to an advertisement or literature announcement. A collection is initiated by the interests and needs of the individuals who will use it. Keeping this collection up-to-date, however, is often the responsibility of the librarian. The library should be added to distribution lists so that new issues are received and filed promptly after publication.

Catalogs may be conveniently filed alphabetically by manufacturer's name. Large, bound catalogs are easily stored on shelves; single sheets and pamphlets may be stored in pamphlet boxes. In this way individual items may be withdrawn directly without recourse to a card file.

Index cards enormously increase the usefulness of the file but also add to the cataloging work load. Cards are filed by subjects or products similar to those used by Thomas' Register or Sweet's. Under each subject heading cards should include a list of manufacturers' names, trade names, and identifying dates and bulletin numbers.

While this and other more complex systems may seem burdensome to set up and maintain, without adequate control catalog files quickly degenerate into disorganized and misfiled stacks of paper. A small library can handle the job with a minimum of engineering supervision, but it takes the time and attention of an already overloaded librarian. Management must recognize the value of this service and provide funds and qualified employees to do it properly.

Buyers' guides are helpful when a class of product is needed but a specific manufacturer not known. *Thomas' Register of American Manufacturers* is published annually by the Thomas Publishing Co., and costs $15.00. It lists manufacturers alphabetically and subdivides them according to product. Trade names are also listed.

Sweet's Catalog Service, a division of F. W. Dodge Corporation, annually issues six bound and classified collections of manufacturers' catalogs. The Product Design File contains catalogs grouped under the following seven major product classifications: metals; plastics, rubber; wood, glass, other materials, finishes; electrical parts; power transmission; mechanical parts and services; fasteners and adhesives.

Three other collections, or Files, have catalogs which are used by other industrial buyers: the Plant Engineering File, for plant maintenance and engineering; the Machine Tool Catalogs, for the selection and purchase of production machinery and accessory equipment; and the Industrial Construction File. All Files are distributed, without charge, to individuals in firms which meet established qualifying standards.

The *Electronics Buyers' Guide* is an annual supplement sent free to subscribers of *Electronics* magazine. Individual copies are available for $3.00 per copy plus a mailing charge. This guide includes reprinted articles from the regular monthly publication, an index to electronics manufacturers by product, trade name, manufacturer and manufacturers' representatives.

Government publications

Federal specifications, standards and the like are probably the greatest single source of printed matter on technical subjects.

Best guide to government publications is issued by the Superintendent of Documents, U.S. Government Printing Office, Washington 25, D. C., entitled *Monthly Catalog of U. S. Government Publications*. The month's publications are listed under the issuing agency with a title and subject index at the back of the issue. Each item includes information as to where the particular document is obtainable and price. At year's end an accumulated index to the year's publications is issued.

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Miss Rose Boots, chief librarian, Mrs. Jean Guasco, associate librarian, and the staff of the McGraw-Hill Library; Mr. Theodore Baumeister, Stephens professor of Mechanical Engineering, Columbia University, and current editor-in-chief of *Mark's Mechanical Engineers' Handbook;* and Miss Marion Lucius, executive secretary, Special Libraries Association.

Directory of publishers

Addison-Wesley Publishing Co., Inc., Reading, Massachusetts.
American Society for Metals, 7301 Euclid Avenue, Cleveland 3, Ohio.
American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pa.
American Society of Heating and Air-Conditioning Engineers, Inc., 62 Worth Street, New York 13, New York.
American Technical Society, 848 East 58th Street, Chicago 37, Illinois.
Cambridge University Press, 32 E. 57 Street, New York 22, New York.
Clarendon Press, 114 Fifth Avenue, New York 11, New York.
Elsevier Press, Inc., 120 Alexander Street, Princton, New Jersey.
Ginn and Company, Statler Building, Boston 17, Massachusetts.
Hafner Publishing Co., Inc., 31 East 10 Street, New York 3, New York.
Handbook Publishers, Inc., Sandusky, Ohio.
Henry Holt & Company, Inc., 383 Madison Avenue, New York 17, New York.
Industrial Press, 93 Worth Street, New York 13, New York.
International Textbook Co., Scranton 9, Pennsylvania.
Interscience Publishers, Inc., 250 Fifth Avenue, New York 1, New York.
Richard D. Irwin, Inc., 1818 Ridge Road, Homewood, Illinois.
Longmans, Green & Co., Inc., 55 Fifth Avenue, New York 3, New York.
Macmillan Company, 60 Fifth Avenue, New York 11, New York.
McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 36, New York.
Oxford University Press, 114 Fifth Avenue, New York 11, New York.
Penton Publishing Company, 1213 West 3rd Street, Cleveland 13, Ohio.
Pitman Publishing Corporation, 2 West 45th Street, New York 36, New York.
Prentice-Hall, Inc., Englewood Cliffs, New Jersey.
Reinhold Publishing Corporation, 430 Park Avenue, New York 22, New York.
Ronald Press Company, 15 East 26th Street, New York 10, New York.
Special Libraries Association, 31 East 10th Street, New York 3, New York.
University of California Press, Berkeley 4, California.
D. Van Nostrand Co., Inc., 120 Alexander Street, Princeton, New Jersey.
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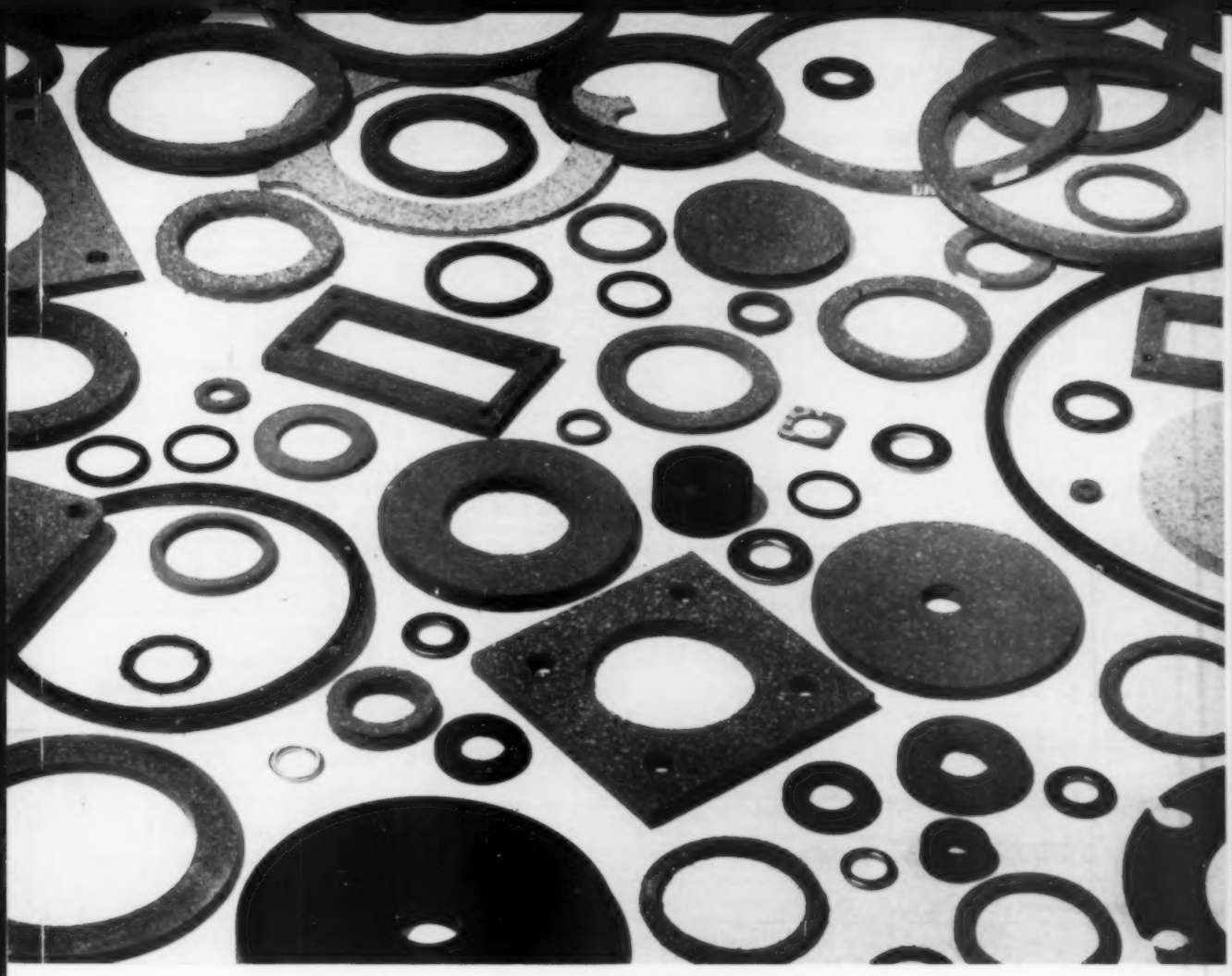

GASKETED JOINTS

. . . *for Electrical Equipment*

- • • Design criteria
- • • Characteristics of ideal gasket material
- • • 8 Common material types
- • • 18 Basic joint designs
- • • Maintaining tightness
- • • Cementing, splicing and assembly

L. E. FEATHER, *Materials Engineer*
Westinghouse Electric Corporation

Requirements imposed on gaskets and gasketed joints for all types of electrical equipment are so diverse that no single gasket material can be used universally; in fact, the ideal material is seldom found for any application. Choice of the best material and joint design involves four basic design criteria:

Fluid to be sealed: Fluids used in electrical equipment are: mineral insulating oil, askarel (chlorinated diphenyl) or gases, generally nitrogen or air. The gasket material should swell slightly upon contact with the sealed fluid or its vapors. A gasket material which swells excessively (or shrinks), exhibits extreme changes in hardness or strength, or contaminates the sealed fluid, should be avoided. Gaskets are generally exposed to air on the outer edge, and should be resistant to sunlight, moisture, ozone,

TABLE I—TYPES OF GASKET MATERIALS USED IN ELECTRICAL EQUIPMENT

	Type	Description	Advantages	Disadvantages
Rubber Compositions	Neoprene	Polychloroprene compounded with fillers and other ingredients to give a rubber of the desired characteristics. Durometer hardness of 45 to 75 most common for electrical equipment.	Good oil resistance. Excellent weather resistance. Physical properties, thermal stability, electrical properties good.	More difficult to fabricate than cork or cork-rubber compositions. More affected by oil than Buna N. Unsuitable for use with askarel due to high swell. Requires close tolerances on joint dimensions. More expensive than cork-rubber compositions.
	Buna N	Butadiene-acrylonitrile copolymer compounded with fillers and other ingredients to give a rubber with maximum oil resistance and minimum compression set at the hardness desired. Durometer hardness of 55–75 most common.	Much better compression set characteristics than cork-rubber compositions; cementing not necessary for permanently tight joints. Very good oil resistance.	More difficult to fabricate than cork or cork-rubber compositions. Tends to develop surface cracks on weather side of gasket, particularly if highly stressed. Requires close tolerances on joint dimensions. More expensive than cork rubber compositions.
	Silicone Rubber	Silicone polymer with fillers and other ingredients to give maximum oil resistance and low compression set. Durometer hardness of 45 to 75 most common.	Excellent askarel resistance, thermal stability and weather resistance. Very good compression set.	Only fair oil reristance. Expensive. Difficult to fabricate. Physical properties only fair. Requires close tolerances on joint dimensions.
Cork Compositions	Cork Composition	Cork particles bonded together with gelatin or resin glue binder. Medium density sheet of fine or medium-fine particles most common. Used principally for temporary test or shipping gaskets.	Cheap. Easily fabricated. Easily cemented. Moderate tolerances on joint dimensions required.	Not completely impervious to air or liquids. Loses resilience on aging at moderate temperatures. Difficult to maintain tight seal even when cemented.
	Cork-Neoprene	Blend of cork particles and neoprene rubber; for most electrical equipment, a medium or soft composition containing 20–50% by weight of cork.	Easily fabricated. Easily cemented to obtain permanent seal. Can tolerate considerable variation in deflection. Good weather resistance. Good oil resistance. Pressure required to deflect gasket is less dependent upon geometry of gasket or condition of flange surface. Low cost.	Higher compression set than straight neoprene or Buna N; cement to obtain permanently tight seal. Cannot be used with askarel.
	Cork-Buna N	Blend of cork particles and Buna N rubber. For use with oil, a medium soft composition containing 30–50% by weight of cork; for askarel, cork content increases to 65%.	Easily fabricated. Easily cemented. Can tolerate considerable variation in deflection. Excellent oil resistance. Good askarel resistance if cork content is high. Low cost.	Less weather resistance than cork-neoprene. Compositions with high cork content are brittle.

TABLE I (con't.)—TYPES OF GASKET MATERIALS USED IN ELECTRICAL EQUIPMENT

Asbestos-Rubber Compositions	Asbestos-Neoprene	Asbestos fibers bonded with neoprene rubber to form a dense relatively incompressible sheet.	Used where high bolting pressures and thin gaskets are possible. Useful as a stop gasket for softer cork-rubber gaskets.	Very high bolting pressures needed, requiring heavy flanges. Small percentage compression allowable; very close dimensional tolerance required. Very high compression set; spring follow or periodic retightening is necessary.
	Asbestos-Buna N	Similar to asbestos-neoprene, except buna-N instead of neoprene used as a binder.	Similar to asbestos-neoprene, except better oil and askarel resistance.	Similar to asbestos-neoprene.

and common industrial atmospheric contaminants.

Operating Pressure: Electrical equipment pressures are low, ranging from a slight vacuum to a maximum of about 15 psi. Under these conditions, considering only the factor of pressure, soft resilient non-recessed gaskets are most often used.

Operating Temperature: Normally ranges from a low ambient temperature of −40 C up to 100 C for liquid-filled apparatus, or somewhat higher for Class H dry type apparatus. This range is within the operating limits for most organic gasket materials. For extreme temperatures silicone rubber has been used satisfactorily.

Gasket Location: Size and shape of the opening to be sealed, frequency of opening and joint loading have considerable influence. In some locations, the electrical characteristics of the joint may be important.

With all of these design requirements, the universal gasket material for electrical apparatus would be a very remarkable material. It would exhibit:

1. High resistance to changes in physical properties upon exposure to mineral insulating oil, askarel or water up to 100 C, or to air or nitrogen up to 200 C.
2. Low compression set characteristics even after a number of years at operating temperature.
3. Resilience down to −40 C, even after long periods of operation at elevated temperatures.
4. Weather resistance under all exposure conditions.
5. Little or no effect on the fluid being sealed.
6. Low cost so that the gasket is a small portion of the total equipment cost.
7. Good workability by cutting, splicing, extruding, molding or other fabricating methods.
8. Good adhesion for splicing or for making a permanent joint.
9. High coefficient of friction to steel, porcelain or copper either dry or when wet with cement or the fluid to be sealed.
10. Sealing over a wide range of deflections, with no damage under large deflections.
11. Moderate compressibility, so gasket geometry will not greatly affect pressure required for desired deflection.
12. Availability from several manufacturers.

Gasket materials most commonly used on electrical apparatus are listed in Table I. For special purposes many other materials are available and in use. No presently available material can be used universally, nor will any single group of materials cover all applications. However, one of the materials listed will be found suitable for the majority of designs. Each listing in Table I is actually a group of materials; one manufacturer lists about 6 different standard grades under each of the 8 headings, and will supply special grades if needed. Table I, therefore, should be used for rough screening, final selection to be made from the many proprietary materials available.

Table II (next page) lists gasket design problems met in electrical equipment, together and with gasket material and joint design combinations to solve them. Specific fabrication and assembly problems are referenced for each case in the footnotes. To the factors in Tables I and II must be added problems peculiar to the individual design: service requirements, equipment life, maintenance problems, economic factors, and customers' specifications. However, these factors will only influence details of the joint, not the basic requirements of good joint design.

Materials

Gasket materials for electrical equipment fall into three broad categories: rubbers, cork and cork-rubber combinations, and asbestos-rubber compositions. The advantages and disadvantages of these groupings are presented in Table I.

Rubber compositions have a rather narrow range of permissible deflections, generally about 20 to 30 per cent. If the gasket is quite wide compared to its thickness, the maximum deflection should be reduced below the 30 per cent allowed. Specific applications for the rubber base materials are noted in Table II.

Cork and rubber combined improves the tear resistance of straight cork as well as providing many characteristics needed in gasket materials. Cork-neoprene and cork-buna N can tolerate deflections from 25 to 50 per cent without damage to the gasket. Additional compressibility imparted by the cork makes reduction of the maximum deflection unnecessary for wide thin gaskets. Cork composition gaskets are usually compressed 35 to 60 per cent.

Rubber-asbestos compositions are much less compressible and hence require high unit loads for sealing. Maximum deflection is about 10 to 20 per cent. This material is often the core of copper-clad gaskets of small diameter for sealing the openings under cover clamping bolts.

Many new gasket materials are available or under de-

velopment. Some of these will be added to Table I as availability improves and experience is gained in their use. At present only limited quantities are available, fabrication is difficult, prices are quite high and many are lacking one or more important properties. For example, one new material has outstanding weather and ozone resistance with very good resistance to oil and askarel; however, its compression characteristics are poor and its price high. At present, its use in electrical apparatus must be limited to those cases where no other material will do.

Maintaining Tightness

Tolerances on the gasket and joint surfaces must insure compression within the recommended range for the particular gasket material to maintain a leak tight joint. If compression is too low, leaks may occur due to insufficient back pressure being exerted on the flange by the gasket. Excessive deflection may rupture the gasket, resulting in leaks; or the gasket will be overstressed, resulting in stress cracking and accelerated aging. From the recommended ranges of deflection given, closer tolerances are required on rubber than on cork-rubber gaskets.

Contact between the gasket and the flanges must be maintained. If gasket material properties and expected apparatus service life permit, resilience of the gaskt material can be used for this purpose. Where a very long service life is required, cementing is the most dependable method of maintaining close contact. A resilient cement with good adhesion will prevent leaks even when the gasket is aged to complete set. For joints opened periodically, cements are undesirable. If the gasket takes a complete set in less than the expected service life of the equipment, spring follow can be incorporated into the flanges, adjacent members or clamping devices. Periodic retightening may also prove practical. Spring follow or

FABRICATION NOTES FOR TABLE II

1. Cork-neoprene or cork-buna N gaskets should be cemented on both sides, using a neoprene or buna N rubber base cement (Shellac or oil proof resin-base adhesives may also be used). Cementing and assembly procedures should conform to recommendations of cement manufacturer.
2. Gaskets should be cemented on one side only. Silicone grease or other anti-adhesive material may be applied to uncemented side to prevent adhesion.
3. Large openings may require use of spliced gasket.
4. Close tolerances on the dimensions of the gasket and the joint necessary for buna N or silicone rubber.
5. Cover should provide some spring action for follow-up pressure on uncemented gasket, if cork-neoprene or cork-buna N is used.
6. Firm copper-clad gasket is necessary to withstand high unit bolting pressure and shear stresses.
7. Cork-buna N gaskets used with askarel should be cemented on both sides, using a shellac base cement.
8. Cork-buna N gaskets used with askarel should contain approximately 65% cork by weight for maximum askarel resistance.
9. Doors are usually light and should be checked for warpage.
10. More dependable seal required than for P and Q; heavier construction, closer tolerances and more careful assembly required.

JOINT CONFIGURATIONS

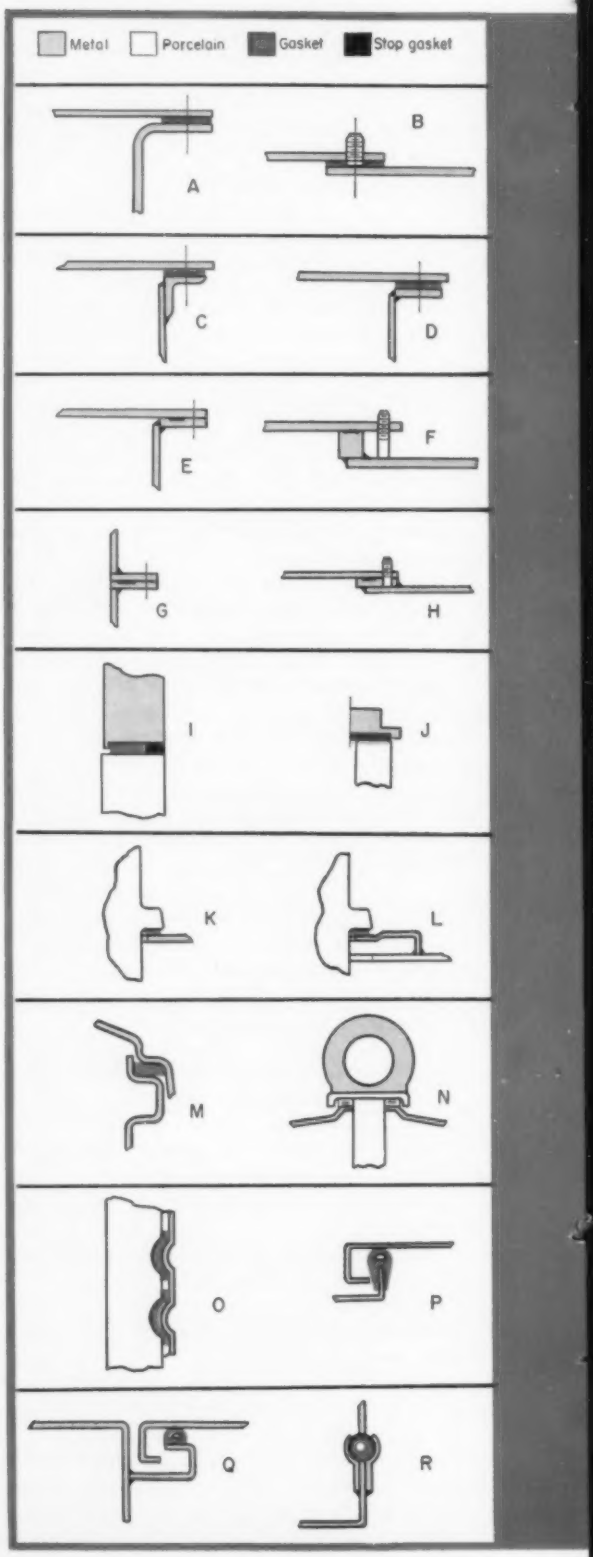

TABLE II—TYPICAL GASKET JOINT DESIGNS FOR ELECTRICAL EQUIPMENT

Type of Equipment and Joint to be Sealed	Configuration	Gasket Materials (In order of preference)	Fabricating and Assembly Problems
A. Oil-Filled Apparatus (Circuit Breakers, Transformers)	(See typical designs at left)		(See notes bottom left)
1. Large permanently attached bolted flange covers			
a. Low mechanical load on joint; accurate alignment not essential.	A, B, C, D	Cork-neoprene Cork-buna N	(1), (3)
b. High mechanical load on joint; accurate alignment required.	E, G	Cork-neoprene Cork-buna N Buna N	(1), (3), (4)
2. Inspection openings	F, H	Buna N Cork-neoprene Cork-buna N	(2), (3), (4)
3. Permanently fastened small circular openings	C, J, K, L	Cork-neoprene Cork-buna N	(1)
	F, G, I	Cork-neoprene Cork-buna N Buna N	(1), (4)
4. Circular pressed steel covers	M	Cork-neoprene Buna N	(4), (5)
5. Cover Clamping Bolt	N	Copper-clad buna N Asbestos	(6)
6. Spun-on bushing hardware	O	Silicone rubber	(4)
B. Askarel-Filled Apparatus (Transformers, Capacitors)			
1. Large permanently attached bolted flange covers			
a. Low mechanical load on joint; accurate alignment not essential.	A, B, D	Cork-buna N	(3), (7), (8)
b. High mechanical load on joint; accurate alignment required.	E, G	Cork-buna N Silicone rubber	(3), (4), (7), (8)
2. Inspection openings	F, H	Silicone rubber Cork-buna N	(2), (3), (4), (8)
	A, B, C, D	Cork-buna N	(2), (3), (8)
3. Permanently fastened small circular openings	C, J, K, L	Cork-buna N	(7), (8)
	F, G	Cork-buna N Silicone rubber	(4), (7), (8)
4. Circular pressed steel covers	M	Cork-buna N Silicone rubber	(4), (5), (8)
5. Cover clamping bolt	N	Copper clad Buna N Asbestos	(6)
6. Spun-on bushing hardware	O	Silicone rubber	(4)
C. Air-filled Apparatus—not sealed tight			
1. Control cabinet doors	P, Q	Neoprene	(9)
2. For other openings see Section A-2			
D. Air or Nitrogen-filled Apparatus—sealed pressure tight			
1. Doors of Submersible Cabinets (e.g., network protectors)	R	Neoprene	(10)
2. Openings on high-temperature apparatus, (e.g. Class H dry-type transformers.)	E, F, G, H	Silicone rubber	(3), (4)
3. For other openings, see Section A. Neoprene may be substituted for Buna N.			

retightening arrangements are not practical when the gasket is recessed and the flanges pulled down metal-to-metal at assembly. Then a permanently resilient gasket or a cemented gasket is the best solution.

Cementing

Choice of cement and the method of application are quite important. For askarel filled equipment, a shellac-base cement is the best type available for use on cork-rubber composition gaskets. Rubber-base cements and most resin-base cements have inadequate askarel resistance and soften or dissolve upon exposure.

Neoprene or buna N rubber-base cement is satisfactory for joints sealing mineral insulating oil or gases. The type of joint and assembly procedure will determine which of the many rubber-base cements should be used. Resin-base cements can be used, but these materials often become hard and brittle upon aging. With exposure to severe temperature cycling, the bond between gasket and flange will break, causing leakage. This will not occur with a properly applied permanently resilient rubber cement.

Splicing

Large gaskets frequently require one or more splices in manufacture. The two most common types of splices are the scarfed or skived joint and the dovetail or keystone joint. In the scarfed type, mating ends of the gasket are tapered uniformly a minimum distance of about four times the gasket thickness. The tapered ends are overlapped and cemented together either before or during assembly of the joint. This splice is best adapted to gaskets at least $\frac{1}{8}$ in. thick. The dovetail joint is made by die-cutting mating ends of the gasket so that they interlock. This joint may or may not be cemented, depending upon whether or not the gasket itself is to be cemented. Dovetail joints are best for gaskets less than $\frac{1}{8}$ in. thick. They are seldom used on thicker gaskets because cupping occurs on the die cut edges, particularly with resilient materials.

Assembly

Careful inspection of the gasket, flanges and cement is an important first step. Flanges should be in good condition, flat, rigid and clean. Recesses should be dimensionally correct, and the gasket surfaces clean and free from heavy deposits of paint. The gasket itself should be clean, flat and dimensionally correct. It should be made from the specified material and free from visible physical defects. If cement is to be used, its freshness and cleanliness require checking. Manufacturer's instructions for application should be followed carefully.

Careful assembly and tightening of the joint will insure that the gasket remains properly located and is not damaged. Tighten the gasket gradually, going around the periphery of the joint several times in order to insure uniform tightening to the correct degree of compression.

Gasket joint design is not an exact science. In many cases, several designs may appear equally suitable. The best design is the one which best coordinates the basic factors—design, gasket fabrication, joint fabrication, and assembly—into a consistently tight and trouble-free joint.

EDITOR'S NOTE: Several articles on gasket design have appeared in the Annual Design Digest Issue:

"Gaskets for Raised Face Flanges" page J14, 5th Annual Digest Issue. Standard Practice establishing limiting dimensions of raised face flange gaskets which meet ASA B16.5 for Class A ratings.

"Eight Gaskets for High Static Pressure" page J30, 3rd Annual Digest Issue. Vessel closures for high static internal pressures. Methods avoid close tolerances on mating surfaces.

"Flowed-in Gaskets" page J30, 2nd Annual Digest Issue. Gaskets produced by pouring liquid gasket material into place and baking to solid film. Three basic material types, technique, and characteristics of finished gasket.

CONFERENCE ON PRODUCT DEVELOPMENT IN MAY

Design development procedures both for end products and for components will be the theme of the Second Annual Design Conference held in conjunction with the Design Engineering Show at the New York Coliseum, May 20 to 23. Conference will again be sponsored by the ASME Machine Design Division. Editors of the four design publications will serve as chairmen: George Nordenholt, *Product Engineering;* Colin Carmichael, *Machine Design;* Henry C. Clauser, *Materials & Methods,* Frank Oliver, *Electrical Manufacturing.*

Procedures in Developing New Designs will be the subject of a panel discussion on the first day. On each of the remaining two days, three concurrent sessions will be held, with papers of particular interest to mechanical, electrical and materials engineers.

Four papers are scheduled for the two mechanical sessions: **New Developments in Design and Application of Gearing, New Developments in Design and Application of Cams, Designing Parts for Easiest Assembly,** and **Hopper Feeding.**

For the electrical session: **Selecting Motors With New NEMA Frame Sizes, Application of Static Controls, Numerical Control for Machinery,** and **Designing Machines for Automatic Control.**

For the first materials session, papers will discuss recent developments in metallic, ceramic, and refractory materials; on the last day, papers on plastics, rubbers, coatings and finishes.

Following the plan of last year, technical sessions will all be held in the forenoon, and will close before the exhibits open at noon. Exhibits will occupy three floors, with more than twice the floor space of the initial show. Advance registration forms and hotel information may be obtained from Clapp & Poliak, Inc., 341 Madison Ave., New York 17, N. Y., managers of the show.

Attendance is expected to reach 20,000, with visitors from at least a dozen foreign countries. Exhibits will include mechanical, electrical, hydraulic and pneumatic components; metallic and non-metallic materials; fasteners; finishes and coatings; shapes and forms, and accessories to product development.

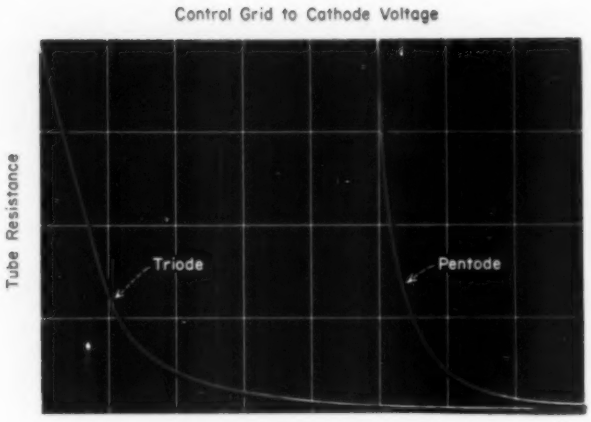

Fig. 1—The vacuum type amplifying tube is in effect, a variable resistance; resistance changes with grid voltage, as shown here for two common tubes. This effect controls the current flow through the tube and thereby produces an output power which is substantially larger than the signal power.

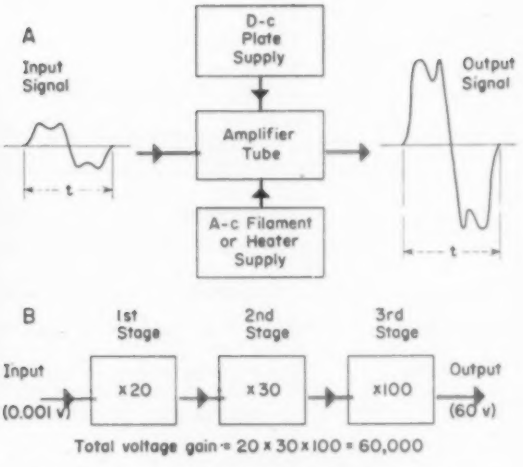

Fig. 2—(A) Block diagram of an amplifying stage and its heater and plate power supplies. (B) Cascading of voltage amplifier stages. Gain of each stage is indicated in block, and overall gain is obtained by multiplying gains of individual stages.

ELECTRON TUBES
for Industrial Applications

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Webb Institute of Naval Architecture

Basic tube types and functions of amplifying, rectifying, switching, transducing, display, and conversion.

Electron tubes generate and control electron currents within the tube and in associated electrical components and circuits. In these tubes electrons flow by influence of electrostatic forces from a source of electrons called the cathode, to an electron collector called the anode or plate. Movement of these electrons produces an electrical current flow which ranges from a few millionths of an ampere (microamp) in cold cathode phototubes to over a thousand amperes in ignitron power rectifiers.

The simplest electron tubes called diodes contain two elements, a cathode and an anode, and are used as rectifiers. To provide a substantially wider range of control and utility, additional electrodes are added between the cathode and plate; these include grids in vacuum tubes and thyratrons, deflecting electrodes in oscilloscope tubes, and ignitor electrodes in mercury pool rectifiers.

Nine industrial tube types are described in Table I. In these tubes the electron source or cathode may be directly heated, such as a filament in an electric light bulb; it may be indirectly heated, in which case the filament is called the heater and the actual cathode is a sleeve surrounding and heated by the filament; or it may be a cold cathode such as found in gas regulator tubes or phototubes. For each of the tube elements and the complete tube, electrical schematic symbols have been devised and standardized. They can be found in "American Standards Association Graphic Symbols for Electrical Diagrams," sponsored by the AIEE and ASME and approved March 1954. In all diagrams the control electrode or grid is the one nearest the cathode. Additional control electrodes are interposed between the control grid and plate, with screen grid next to control grid and suppressor grid next to plate.

Power Amplification

Electron tubes produce two basic types of electrical power amplification, proportional and switching. The proportional type delivers an essentially precise reproduction of a varying electrical signal or input voltage, but at a higher voltage or power level; triode (three element) or pentode (five-element) vacuum-tube amplifiers are examples. These tubes are, in effect, a variable resistance, with the

TABLE I—INDUSTRIAL TUBES

Type	Description	Means of Unidirectional Current Control
Glow Tube	A gas-discharge tube with an anode and a cold cathode.	None
Kenotron	A high-vacuum tube with an anode and a hot cathode.	None
Phanatron	A gas-discharge tube with one, sometimes two, anodes and a hot cathode.	None
Phototube	A vacuum or gas tube in which electron emission is produced by radiant energy striking an electrode. Sensitivity of gas tube is greater than vacuum but frequency response is lower.	None
Grid-Glow Tube	A gas-discharge tube with one or more electrodes which control the starting of current flow; it has a cold cathode.	None
Grid-Pool Tube	A gas-discharge tube with one or more electrodes which control the starting of current flow from a pool-type (liquid or solid) cathode to an anode.	Electrostatic grids or elements.
Pliotron	A high-vacuum tube with an anode, a hot cathode, and one or more additional electrodes (grids) to control current flow.	Electrostatic grids or elements
Thyratron	A gas-discharge tube with an anode, a hot cathode, and one or more electrodes (grids) to control current flow.	Electrostatic grids or elements
Ignitron	A gas-discharge tube with an anode, a pool-type cathode, and an ignitron electrode which controls the starting of current flow.	Ignitron electrode
Oscilloscope	A vacuum tube with a hot cathode called an electron gun from which electrons are accelerated to strike a phosphor screen and produce a visible spot.	Electrostatic accelerating and deflecting electrodes or electromagnetic deflecting yoke.

magnitude varied by change in the level of the voltage applied to the control grid, as shown in Fig. 1. Tube resistance varies with control voltage in a gradual fashion, and amplifiers using these tubes can easily be designed to respond to input signals as short as millionths of a second (microsec) or less. Consequently they are used for a wide range of signal frequencies and where accurate reproduction of the input signal is desired.

Vacuum tubes are not efficient; power input is high as compared to the power output. These tubes commonly use two power supplies: a filament or cathode-heater supply, usually a-c, which heats the filament or cathode sufficiently to produce electrons; and a d-c plate supply which provides the electrostatic forces to cause electrons to flow from the cathode to the plate. The block diagram of a single stage of amplification including power supplies is shown at (A) in Fig. 2.

Typical amplifier tubes such as triodes or pentodes are often used in low-power circuits. Control signals of a few millivolts or microwatts can change tube resistance and current flow in the associated electronic components sufficiently to produce output power in the order of milliwatts. Typical sources for signals of this level include transducers such as photoelectric tubes, accelerometers, strain gages, and piezoelectric or magnetic pickups.

Because of the low power involved these amplifiers are normally rated in terms of voltage amplification rather than power and are hence called voltage amplifiers. For a single stage of amplification, which includes a tube and its associated components, the ratio of the voltage input to the voltage output may be 100 or more. Where additional gain is required the stages are cascaded, as at (B) in Fig. 2; for the overall ratio the voltage gains of each stage are multiplied. The gain required is primarily determined by the voltage level of the signal and the desired output power. For typical applications it is in watts.

In general, vacuum tube amplifiers are low power devices; for higher outputs they often drive magnetic amplifiers or rotating amplifiers. However, substantial power can be produced by high-voltage vacuum tubes using plate voltages of several thousand; but tube currents are limited to an ampere or less.

Vacuum tube amplifiers are less efficient and shock resistant than magnetic or solid state amplifiers. Transistors are more efficient but are not yet available with the high power outputs obtained from tubes.

Second basic type of electrical power amplification is obtained by an on-off switching action in vapor-filled tubes. They can be turned ON when anode and grid voltages have proper values and turned OFF when the anode voltage falls below the level required to support conduction. The vapor-filled tube may have a heated cathode as in the thyratron or it may have a mercury-pool cathode as in the ignitron. In either case it will conduct when the anode is positive with respect to the cathode.

Amplification in vapor-filled tubes can be varied by adjusting the timing of the switching action: tubes may be made to conduct for a larger or smaller part of each positive half cycle of anode voltage. If a d-c power is supplied to the anode, control of firing is lost after the tube is once fired. With a-c power supply as ordinarily used the grid or igniter regains control during each negative half cycle. Because conduction can occur only when the anode is positive with respect to the cathode, the anode current consists of one burst of current per cycle of anode voltage. To increase the average load current, a full wave connection with firing on each half cycle of supply voltage can be used. Multiphase connections can be used to increase the relative smoothness of the output current.

The vapor-filled tube is more efficient and handles higher power than the vacuum tube, because the internal resistance of the tube is in the order of a few ohms compared to a thousand or more of the vacuum tube. The vapor-filled tube can be applied for manual or automatic control of current or voltage in lamps, motors, generator fields, slip couplings and so on. But the magnetic amplifier, which is inherently more durable, is now used in many applications where the vapor-filled thyratron formerly was used.

Rectification

Both vacuum and gas-filled tubes are used as rectifiers, as indicated in Table II. Vacuum tube rectifiers or kenotrons are used in low current d-c power supplies working from a-c power lines—at 500 volts or less and up to about 0.3 amp. During the past few years, however, solid-state rectifiers—selenium, germanium, and most recently, silicon—are being used as rectifiers to an increasing extent. The vacuum-tube rectifier is well suited for unusually high voltages (150,000) such as are needed in electrical precipitators for fly ash collection, paint spray collection and so on.

Gas- and vapor-filled two-electrode rectifier tubes or phanotrons have useful currents in the range of 1 to 10 amp (average value) and voltage ratings from 700 to 22,000 volts. These tubes have heated cathodes like the thyratron but if the ambient temperature is too low, they will fire erratically. Inert-gas-filled phanotrons are less affected by temperature than those filled with mercury vapor. They have lower internal resistance than vacuum tubes.

Ignitron tubes have mercury-pool cathodes and therefore current rating is not limited by the thermal emission of heated metal. The igniter electrode initiates conduction during the positive half cycle of anode voltage. The average output voltage can be adjusted by the duration of the conduction interval. Phase shift control can be used but the firing circuits are not so simple as those for the thyratron. The igniter voltage pulse must be of sufficient magnitude and duration to initiate ionization but not to burn off the igniter electrode. This demands more critical control circuits than a simple a-c phase shift circuit.

The ignitron is used for heavy duty power rectification. Water cooling is usually used since temperature control is important for successful operation.

Switching

Vacuum tubes are used for high-speed switching of low power levels—either intermittently or repetitively—at rates up to thousands of times per second. When the grid is at sufficiently negative potential with respect to the cathode, the tube in effect is an open circuit.

The thyratron and ignitron, as grid controlled rectifiers or power amplifiers, act as high speed switches to connect the positive half cycles of anode voltage to the load. They can also be cross connected to switch a-c power for full cycle or part cycle conduction. Resistance welder controls are of this type. High speed, precise control of heat and time, lack of moving parts and the absence of metallic contacts are advantages. Complexity of the control circuits is the chief disadvantage. If operation occurs at irregular intervals with several seconds or minutes between operations, the contactor or relay is the simpler and lower cost device.

The vacuum switch is a mechanical device with contacts mounted in an evacuated envelope for protection from dust, oxidation and corrosion. Absence of ionized gas between the contacts following an opening increases the speed of current interruption. The movable contact is operated by a push rod working through a metal diaphragm, and operating travel is a few thousandths of an inch. These switches can be used in explosive environments and submerged in conducting fluids. They are available in ratings of 1 to 2 amp a-c for 1 million operations. Maximum continuous current is 10 amp with a life expectancy of about 1000 operations. Maximum allowable operating force is in the order of 2 lb.

Transducers

The term transducer has come into use during the past few years to describe those devices which convert energy from one form to another or which convert quantities measured in the various energy systems to quantities in other energy systems. For example, an electric tachometer transduces a rotational velocity into a voltage. A gas type thermometer changes a pressure to a temperature and a Bourdon gauge converts a pressure to a mechanical movement.

Tubes function as transducers between electrical energy and luminous or thermal energy. For example, light falling on the cathode of a phototube causes current flow in the order of microamperes which is proportional to the light input. A voltage proportional to the light input can be developed across a resistor in the anode circuit. The

TABLE II—COMPARISON OF INDUSTRIAL TUBE TYPES, FUNCTION, AND APPLICATION

Function	Tube Type	Type of Control	Type of Output	Associated Circuits	Output Rating
Amplification	Vacuum Tube (Pliotron)	Voltage	a-c or d-c	Medium Complex	Milliwatts to Kilowatts
	Thyratron	Phase Shift	a-c or d-c	Simple	½ Ampere up
	Ignitron				Less than 15,000 V. d-c.
Rectification	Vacuum Diode (Kenotron)	None	½ Cycle Pulses	Simple	Milliamperes to Amperes 100,000 V, d-c Down
	Gas Diode (Phanotron)				
	Thyratron	Phase Shift	Part Cycle Pulses	Simple	½ Ampere Up
	Ignitron				Less than 10,000 V. d-c
Switching	Vacuum Tube	Voltage	High Resistance	Complex	Milliamperes
	Thyratron	Phase Shift	Low Resistance	Complex to Simple	20 to 400 Amperes Average
	Ignitron				To 15 Amp. Continuous Rating
	Vacuum Switch	Mechanical Force	Low Resistance	None	10 Amp. a-c, 1,000 Oper. 2 Amp. a-c, 1,000,000 Oper.
Transducers	Phototubes	Light	Current or Voltage	Simple	Microampere Range
	Ultraviolet Lamps	None	Light	Simple	Up to 2,000 Lumens
	Infrared Lamps				0–600 Microns
	Vacuum Gauge	None	Resistance Change	Simple	180–350 Milliamperes
Display	Neon Lamp	Voltage	Color	Simple	Low intensity
	Electron-Ray Tube	Voltage	Bright Segment	Complex	
	Cathode Ray Tube	Voltage	Light Spot	Complex	
Conversion	Vacuum Tube Oscillator	Tuned Circuit	a-c Voltage	Complex	Up to 30 Kw.
	Voltage Regulator Tube	Current	d-c Voltage	Simple	100 to 150 Volts

spectral sensitivity of phototubes depends on the cathode material and the glass used in the envelope; while it is not the same as that of the human eye, the sensitivity is in the range of visible wavelengths. Gas at low pressure, added to a phototube, increases the magnitude of electrical response to light but alters the linear relationship between light input and anode current. For very low luminous intensities, phototubes are available with electron multipliers. Amplification is necessary for driving relays or contactors.

The ultraviolet lamp and the infrared lamp yield invisible light which can be used for processing material.

The resistance vacuum gauge offers a convenient means of measuring low pressures. It operates by applying a constant voltage to a piece of temperature-sensitive resistance wire and measuring the current. When the level of vacuum varies current flowing through the wire is a function of pressure.

Display

The neon lamp is a gaseous discharge tube which glows to indicate the presence of voltage on a pair of wires; it will indicate if the voltage is a-c or d-c and requires negligible power. The intensity of the glow is, in general, proportional to the applied voltage.

The electron ray tube or "magic eye" is a useful display device which consists of a combined vacuum tube amplifier and a cathode ray indicator in one envelope. The size of a brightly glowing fluorescent segment varies with voltage applied to the input terminals. It can be used as a voltage indicator. The magnitude of any quantity which can be transduced into a d-c voltage of a few volts can be displayed in this way as a bright segment of a glowing circle.

The most significant device for the display of electrical quantities is the cathode ray tube. The cathode beam is a thin stream of electrons which produce a visible fluorescent spot on the face of the cathode ray tube. Both horizontal and vertical deflection of the luminous spot are possible.

Any quantity which can be converted to an electrical voltage can be displayed on the screen as a time function or as related to some pertinent quantity. Industrial tubes are available with screens from 2 to 21 in. as used in cathode ray oscilloscopes. They require complicated associated circuits but often present the only appropriate way

Typical Electrical Function	Typical Application
Amplification of Time Varying a-c or d-c Voltages	Amplifying Voltage from Vibration Pickup
Averaged Amplification of a-c or d-c Voltages	Controlling Motors or Generators
Rectification of High Voltage	Producing High d-c Voltage for Electrical Precipitation
Rectification of Medium High Voltage	Producing d-c Plate Voltage for Induction Heating Oscillators
Production of d-c with Voltage Regulation	Speed Control of d-c Motors
Very High Speed Intermittent or Repetitive Switching	Digital Computation and Displaying Two Quantities Simultaneously
High Current, Repetitive Switching	High Rate Precision Switching of Spot Welders
Low Current Switching	Switching in Hazardous Environments
Obtaining Voltage Proportional to Illumination	Inspection of Sheet Metal for Pin Holes; Safety Stops
Production of Invisible Light	Inspection
	Drying Paint
Obtaining Current Reading which is A Function of Pressure	Measurement of Vacuum
Voltage Indication	Annunciators and Pilot Lamps
Voltage Measurement	Adjustment of Tuned Circuits for Voltage Maximum
Display of Magnitude or Time Variation of Voltage	Deflection Display on High Speed Balancing Machines
Sustaining Oscillations in Tuned Electrical Circuits	Induction Heating Units, Tin Reflow Units
Producing Constant d-c Voltage	Obtaining Standard Voltage for Control Circuits

of presenting necessary information. High speed balancing machines and testing apparatus where an electrical signal yields important information are prime users. Writing speeds can be very high and the trace can be retained for several seconds by the use of long-persistance phosphors.

Conversion

Voltage-amplifying properties of vacuum tubes make them useful in converting the low-voltage heater supply and d-c plate supply into electromagnetic oscillations in tuned electrical circuits. Here, a portion of the a-c voltage developed in the output circuit is returned to the input circuit and the tube acts as a continuous self-amplifier. This results in sustained oscillations at a frequency determined by the characteristics of the associated components. Induction heating units in the megacycle range make use of vacuum tube oscillators. All input energy is supplied by the 60 cps power line, but the output energy is independent of the supply frequency. The device is thus a frequency converter.

Voltage regulating tubes are converting devices in the sense that they change a varying d-c voltage into a steady d-c voltage. This is useful in obtaining d-c reference voltage in voltage-regulating circuits. This type tube is a gas-filled, cold-cathode tube which glows when a sufficient voltage is applied to it. Above a certain voltage, called the "striking" voltage, a small increase in voltage produces a large decrease in internal resistance. In similar fashion, a small decrease in voltage produces a relatively large increase in tube resistance.

Use of this type tube provides an inexpensive means of regulating voltage. It is connected in series with a resistance and the voltage which is to be regulated is taken from the common connection. The value of this resistance must be sufficiently high to limit current through the tube to its rated maximum. The voltage from the d-c power supply must also be high enough so that the glow-tube current and voltage do not drop below minimum rating. If this occurs, the glow in the tube vanishes and it becomes nonconducting.

EDITOR'S NOTE: Another article by the same author, "Magnetic Amplifiers as Control Components", August 1955 page 105, compared input signals, power output, and response time of magnetic amplifiers, variable transformers, relays, and vacuum and gas tubes.

Fastening Studs and

Ten removable and five permanent methods for fastening studs that provide pivots for linkages, act as stop pins, or register of parts in assembly.

REMOVABLE ASSEMBLIES

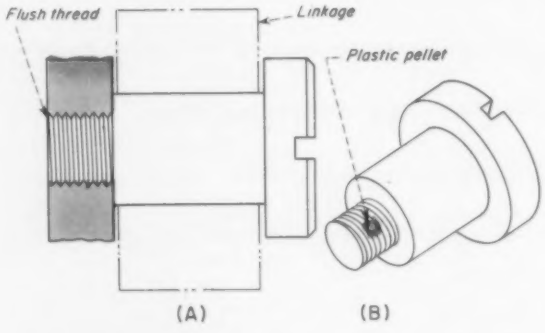


Fig. 1—(A) Shoulder screw in threaded hole may have slotted head. Thickness of mounting plate should be at least equal to thread diameter—especially if design does not allow thread to protrude or to be cut flush. (B) Loosening of screw can be prevented by having plastic pellet inserted into body of thread, or patented, self-locking threads.

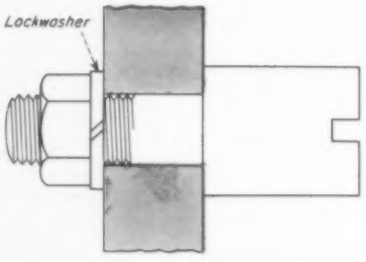


Fig. 2—Shoulder screw in unthreaded hole requires nut and washer. Plate can be any thickness. Loosening of screw is prevented by lock washer or by using a lock nut.

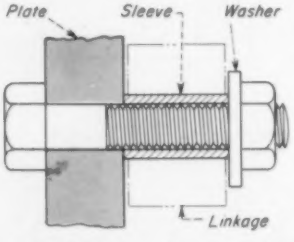


Fig. 3—Standard bolt and nut can be used to hold movable linkage by using sleeve to prevent binding when screw is tightened..

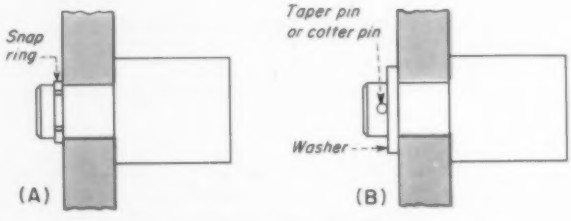


Fig. 4—Where end play is permissible, stud can be retained by (A) unthreaded shoulder pin and snap ring; (B) washer and cotter or taper pin. Wedging effect of taper pin prevents end play if pin is properly located.

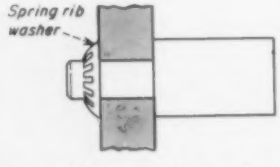


Fig. 5—Quick assembly is obtained with spring rib washer but slippage may occur with high loads. Also stud is difficult to disassemble.

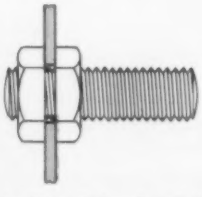


Fig. 6—Threaded rod provides for axial adjustment in sheet metal assemblies by clamping plate between two nuts (usually lock nuts).

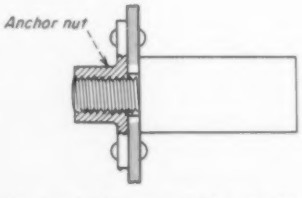


Fig. 7—Anchor nut enables shouldered stud to thread into thin sheet metal when only one side of plate is accessible.

Pins to Plates

D. MASCIO
Supervising Engineer
R. Hoe & Co., Inc

REMOVABLE ASSEMBLIES

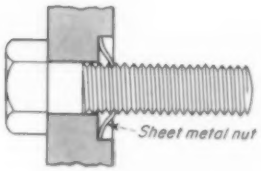


Fig. 8—Sheet metal nut and standard screw make simple fastening for small mechanism assemblies. Nut can be recessed.

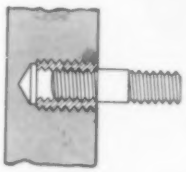


Fig. 9—Inserts with tapped hole provide seat in plastic or soft metal for standard stud threaded on both ends. Inserts are retained in plate by various patented methods.

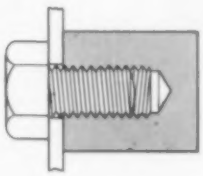


Fig. 10—Stud with tapped hole is retained in thin sheet metal with standard screw. Hole can be tapped all the way through.

PERMANENT ASSEMBLIES

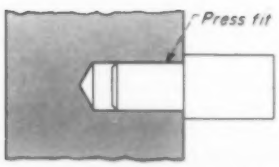


Fig. 11—(A) Shoulder stud is pressed into hole in plate. Holding power can be improved by using brazing ring or (B) having groove pressed on the shank by licensed manufacturers.

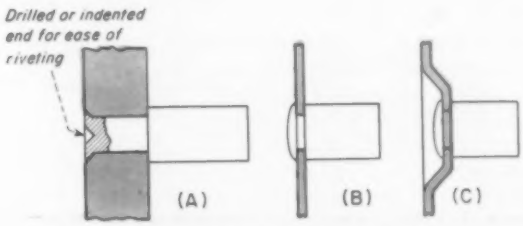


Fig. 12—(A) Riveted shoulder stud in clearance hole is center drilled for ease of riveting. Plate countersunk for flush riveting. (B) Riveting over sheet metal will not be flush unless (C) metal is indented.

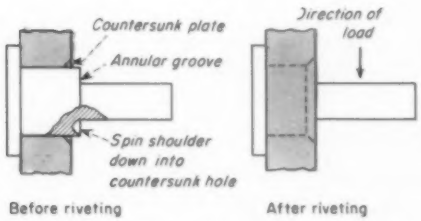


Fig. 13—Stepped-up stud does not reduce shear area at junction of pin and shoulder (as in Fig. 12 A). Therefore, for same pin diameter shear strength is higher. Also, when stud is used as a stop pin, head of stud resists shock loads which may cause stud in Fig 12 (A) to pull out.

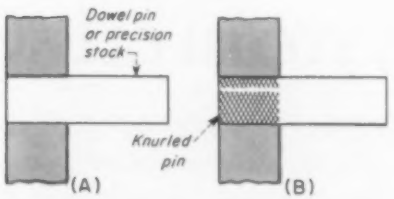


Fig. 14—(A) Press-fitted dowel pins can be used for small sizes up to ½ in. dia.—precision stock for larger diameters. Press fit is also obtained with knurled pin (B) or with patented items such as grooved pins, slotted tubular pins, spirally rolled pins.

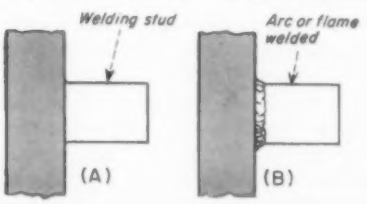
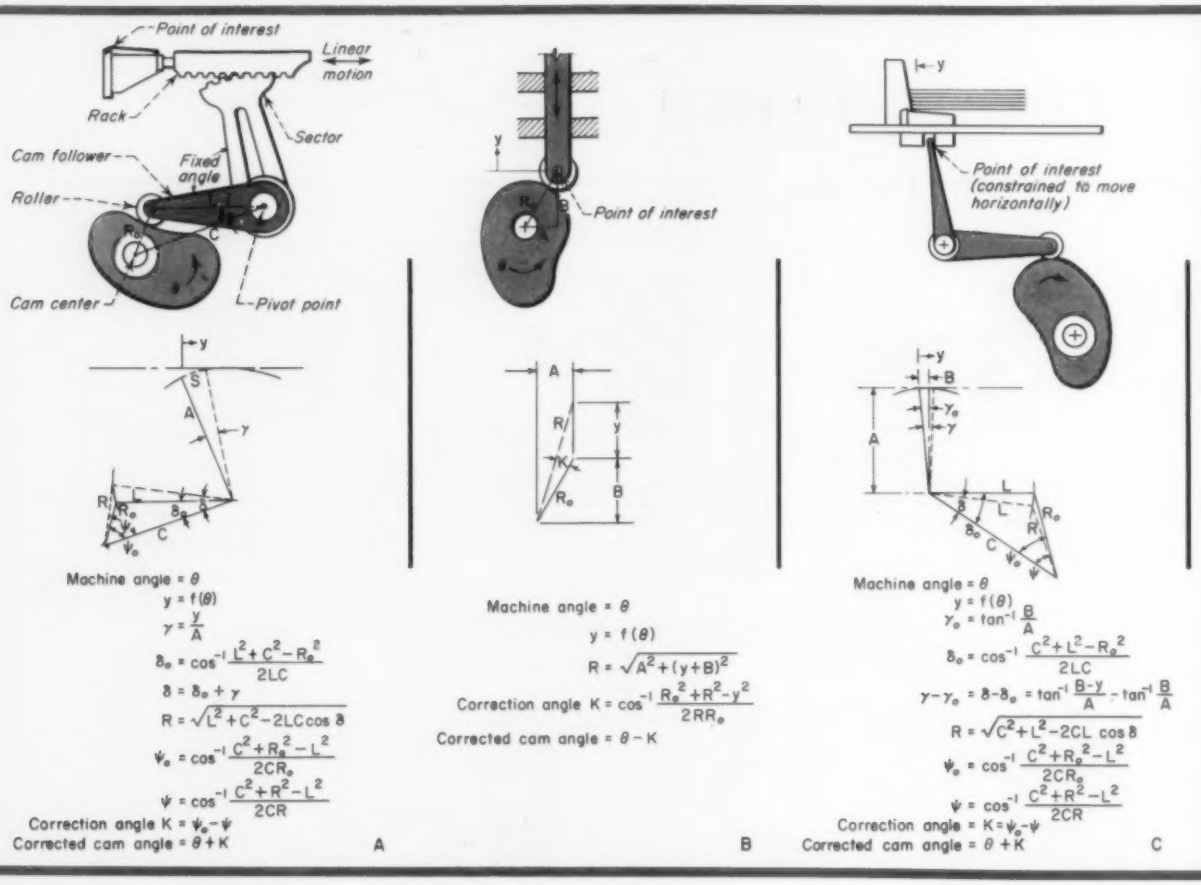


Fig. 15—(A) Special studs for welding allow dissimilar metals to be welded, which is frequently impossible with resistance welding. Special gun for welding creates little heat, therefore no distortion. (B) Flame welded studs have fillet around bottom.


Point of interest
Linear motion
Rack
Sector
Cam follower
Fixed angle
Roller
Cam center
Pivot point
Point of interest
Point of interest (constrained to move horizontally)
Machine angle = θ
y = f(θ)
γ = y/A
δ₀ = cos⁻¹ (L² + C² − R₀²)/2LC
δ = δ₀ + γ
R = √(L² + C² − 2LC cos δ)
ψ₀ = cos⁻¹ (C² + R₀² − L²)/2CR₀
ψ = cos⁻¹ (C² + R² − L²)/2CR
Correction angle K = ψ₀ − ψ
Corrected cam angle = θ + K
A
Machine angle = θ
y = f(θ)
R = √(A² + (y + B)²)
Correction angle K = cos⁻¹ (R₀² + R² − y²)/2RR₀
Corrected cam angle = θ − K
B
Machine angle = θ
y = f(θ)
γ₀ = tan⁻¹ B/A
δ₀ = cos⁻¹ (C² + L² − R₀²)/2LC
γ − γ₀ = δ − δ₀ = tan⁻¹ (B − y)/A − tan⁻¹ B/A
R = √(C² + L² − 2CL cos δ)
ψ₀ = cos⁻¹ (C² + R₀² − L²)/2CR₀
ψ = cos⁻¹ (C² + R² − L²)/2CR
Correction angle = K = ψ₀ − ψ
Corrected cam angle = θ + K
C

Computers Simplify Solutions of

Polynomial Cam Curves

Equations for specifying cam contours; curve-fitting methods using polynomial equations with ten constants; comparison of polynominal curves with common cam curves; use of computers in solving cam problems.

In the design of cam contours, high-order polynomials offer the important advantage of obtaining smaller acceleration peaks than are given by trigonometric curves. But high-order polynomials involve lengthy calculations, particularly in defining contours at half-degree intervals or smaller, and the mathematical procedure for deriving the necessary constants is generally unfamiliar.

With the growing use of computers in engineering design, this limitation of calculation time is becoming less significant. With digital computers the extensive curve-fitting computations required for polynomials can be completed rapidly and, quite often, economically. For example, a problem requiring over 100 hr of computations with a desk calculator can be performed in a matter of minutes on the IBM 650 computer.

Specifying the Cam Contour

First step in specifying the contour of a cam is to derive equations relating the motion of a point on the cam follower mechanism to the radial dimensions of the cam. These equations are then fed into a computer or a desk calculator. Motion of this "point of interest" on the cam follower mechanism is rigidly prescribed by trigonometric or polynomial curves and it is assumed that the mass of the system is concentrated at this point. Both functional requirements and dynamic restraints are satisfied by deal-

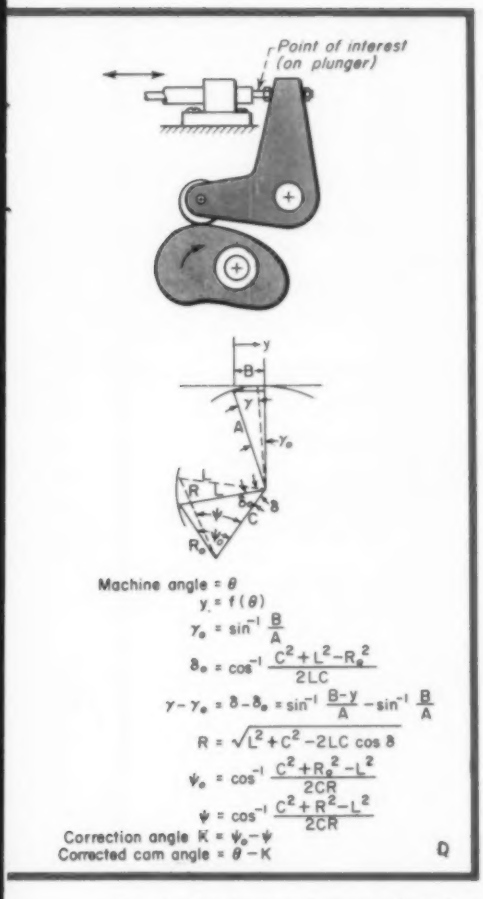


Fig. 1—Relationship between desired motion of "point-of-interest" on the cam follower mechanism and the radial dimensions of the cam. **For explanation of symbols see page 199.**

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International Business Machine Corporation

ing with this point only because the acceleration pattern is continuous and virtually the same at all points in the mechanism.

To relate the motion of the "point of interest" to the cam dimensions, a kinematic analysis is made tracing the displacement of the point through the cam follower mechanism to the cam radius.

Example: A picker knife device which is used to feed cards in IBM machines is illustrated in (A) of Fig. 1. The edge of the knife is the point of interest. After the point has been displaced a linear amount equal to y in accordance with one of the motion curves, the cam radius R must be found at the new position. (To simplify the analysis the cam radius includes the roller radius). Trigonometric relationships shown in (A) are derived as follows: Linear distance y = arc length s, therefore

$$\gamma = s/A = y/A \tag{1}$$

Since a change in γ results in an equal change in δ.

$$\delta = \delta_0 + \gamma = \delta_0 + y/A \tag{2}$$

Knowing δ, the cam radius can be found by the law of cosines as follows:

$$R = \sqrt{L^2 + C^2 - 2LC\cos\delta} \tag{3}$$

During displacement y the cam has turned through an angle θ. However, because the center of the follower roller is moving along a circular arc instead of radially, the actual angle between R_0 and R is $(\theta + K)$ where K is called the correction angle. The correction angle K is equal to:

$$K = \psi_0 - \psi \tag{4}$$

Values of ψ and ψ_0 can be obtained from the following equations (based on the law of cosines):

$$\psi_0 = \cos^{-1}\frac{C^2 + R_0^2 - L^2}{2\,C\,R} \tag{5}$$

$$\psi = \cos^{-1}\frac{C^2 + R^2 - L^2}{2\,C\,R} \tag{6}$$

and the corrected cam angle θ' from the equation:

$$\theta' = \theta + K \tag{7}$$

Therefore, for each incremental displacement y of the point of interest, the radial distance to the roller center can be found from Eq (3), and the angular distance between successive radial dimensions determined by Eq (7).

To specify the cam dimensions, this series of calculations are repeated n times where n is the number of increments into which the total motion is divided.

In the above example, the cam follower swings along a circular arc and therefore is called a "swinging follower" system. The correction angle is always present in swinging follower systems. When the follower is constrained to move in a straight line which does not pass through the cam center, the mechanism is called an "offset follower" system and again, a correction angle is present, such as in (B) of Fig. 1. Simplest system is where the follower moves in a straight line which passes through the cam center. This is called a "radial" follower system and no correction angle is necessary.

Trigonometric relationships between the motion of the "point of interest" and the cam dimensions are illustrated in (C) and (D) for other common linkages.

Polynomial Curves

Synthesis of the cycloidal, harmonic and special polynomial profiles to satisfy the functional requirements of the cam system was discussed in a previous article (see Editor's note). This method is an extremely convenient and flexible tool in cam design.

However, with the necessity for operating mechanical devices at speeds of several thousand rpm, many cam problems arise which cannot be satisfied by the three basic curves. The half cycloids and half harmonics, for example, are determined by three parameters: rise L, cam rotation β and initial or final velocity V. When two of these parameters are fixed by design, the third can then be determined. Should all three parameters be fixed, as may occur with high-speed requirements, other curves such as the high-order polynomials must be used.

Important consideration at high speeds is to keep the acceleration peaks to a minimum. The parabolic profile, while having the lowest possible maximum acceleration, is undesirable because of the infinite "jerk" occurring during the cycle caused by the instantaneous change in accel-

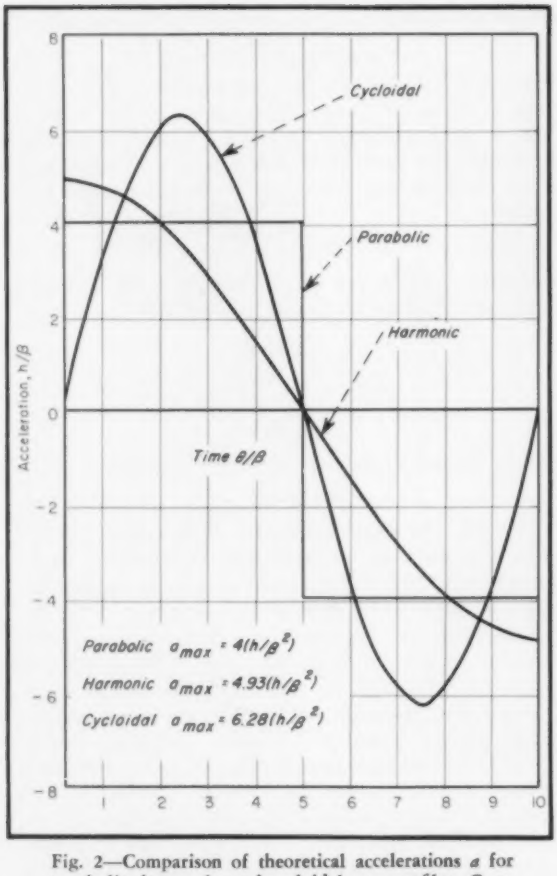


Fig. 2—Comparison of theoretical accelerations a for parabolic, harmonic, and cycloidal cam profiles. Comparisons are made by keeping the cam rise b and cam angle β constant for all three curves.

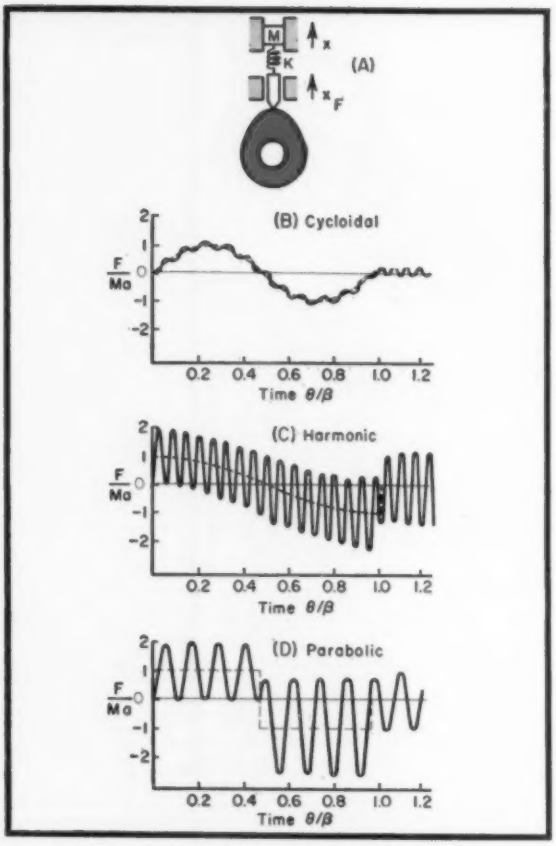


Fig. 3—Influence of acceleration changes on the dynamic response of the cam follower system shown in (A). Dashed lines are theoretical inertia forces: solid lines are actual inertia forces determined from studies by J. A. Hrones, reported in an ASME paper.

eration from a positive to a negative quantity, as can be noted in Fig. 2. The harmonic acceleration curve is continuous between end points but care must be taken to match accelerations at the ends. The same is true for the cycloid acceleration curve.

If the output force of the cam is applied to a spring-mass system, such as shown in Fig. 3 at (A) and damping is neglected, a comparison can be made of the dynamic forces created by various cam curves. Ratio of the actual dynamic force F to the rigid body inertia force Ma is plotted against the machine angle θ/β for the parabolic, harmonic and cycloidal cam curves, assuming dwells at both ends of the motion. The theoretical inertia force Ma is shown by dotted lines. It can be seen that the instantaneous changes of acceleration in the parabolic and harmonic motions give rise to dangerous transient oscillations which are absent in the cycloidal motion. The cycloidal curve will have the smoothest dynamic response.

Referring again to Fig. 2, it is seen that the ratios between maximum accelerations are as follows:

$$\frac{\text{Harmonic}}{\text{Parabolic}} = 1.23$$

$$\frac{\text{Cycloid}}{\text{Parabolic}} = 1.57$$

It can be safely assumed that there must be curves which would give ratios closer to unity. The cycloidal and harmonic curves can be improved—but this improvement must be made without incurring dangerous dynamic conditions such as demonstrated in Fig. 3. One solution is the use of a high order polynomial with sufficient arbitrary coefficients to satisfy a given set of conditions. For example, a polynomial of the form

$$y = A_0 + A_1\left(\frac{\Theta}{\beta}\right) + A_2\left(\frac{\Theta}{\beta}\right)^2 \cdots\cdots + A_9\left(\frac{\Theta}{\beta}\right)^9$$

has 10 arbitrary constants A_0 to A_9, which is of sufficient number for most cam problems. Generally the displacement, velocity and acceleration are specified for $\theta/\beta = 0$ and $\theta/\beta = 1$, thus fixing six of the constants. By choosing the third derivatives at $\theta/\beta = 0$ and 1, two other constants are fixed. The last two constants are fixed either by specifying values for the fourth derivative at the end points or by forcing the polynomial to go through a given interior point with a given slope (velocity). Ten simultane-

SYMBOLS

a	acceleration	L	length of follower arm	y	linear displacement of point of interest
A	constants to be determined	N	revolutions	β	cam angle (can be specified in terms of time)
C	distance between cam center and follower arm pivot point	R	cam radius measured from cam shaft center to roller center	θ	machine angle (can be specified in terms of time)
g	acceleration due to gravity	t	time		
K	correction angle	V	velocity	δ, γ, Ψ	angles as defined in Fig. 1

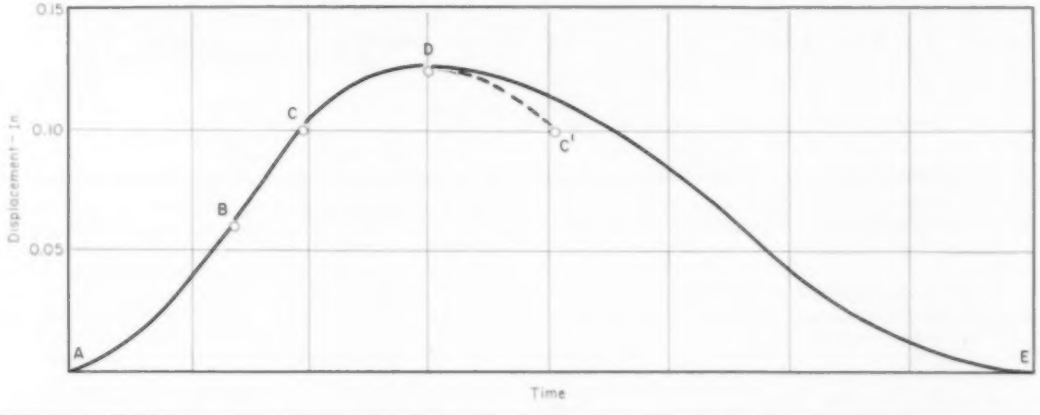


Fig. 4—Cam displacement diagram used to illustrate sample problem for deriving high-order polynomials with ten constants.

ous equations must be solved to find $A_0, A_1 \ldots A_n$, and the polynomial and first two derivatives are evaluated for various values of θ/β.

Should the properties of the derived curve be undesirable (generally this comment refers to maximum values of the acceleration since the displacement and velocity are usually satisfactory) the approximations for the third derivative are changed judiciously and the process repeated.

Example: One of the card feed mechanisms developed at IBM is the cam driven "picker knife" device shown in (C) of Fig. 1. The card is "picked off" the stack and accelerated by the cam to a desired velocity, equal to the peripheral velocity of a set of feed rolls. The cam then returns the follower to the starting point. Displacement diagram is shown in Fig. 4.

Acceleration to the constant velocity portion from point *A* to point *B* is accomplished with a half cycloidal curve. The return stroke *DE* is a polynomial but the troublesome portion is curve *CD* whose function is to decelerate the follower from the large velocity at C without exceeding the permissible rise of 0.125 in. This problem is analogous to that of a vehicle trying to approach a wall as close as possible at a high rate of speed and still come smoothly to a stop before striking it.

Given conditions in the problem are:

Rise *CD*: $L = 0.025$ in.
Velocity at *C*: $V = 75$ in./sec
Displacement at C: $L_T = 0.100$ in.
Rotation of cam: $N = 2000$ rpm.

A half cycloid can be used for the portion *CD*, but this would entail a needless return to zero acceleration at point *D*. For comparison reasons, however, the calculations are made. For a half cycloid:

$$\beta = \frac{2L}{V} = 6.667 \times 10^{-4} \text{ sec}$$

$$a_{max} = -\frac{\pi L}{\beta^2} = -177{,}000 \text{ in./sec}^2 = -457\, g$$

For a half harmonic

$$\beta = \frac{\pi L}{2V} = 5.236 \times 10^{-4} \text{ sec}$$

$$a_{max} = \frac{-\pi^2 L}{4\beta^2} = -225{,}000 \text{ in/sec}^2 = -582\, g$$

Maximum acceleration for a full harmonic is less than that for a full cycloid if the rise and the time are equal (as in Fig. 2). However, when the half curves are used and the initial velocity is specified, the harmonic takes less time to cover the same rise and consequently has a larger value of maximum acceleration than the cycloid. In fact,

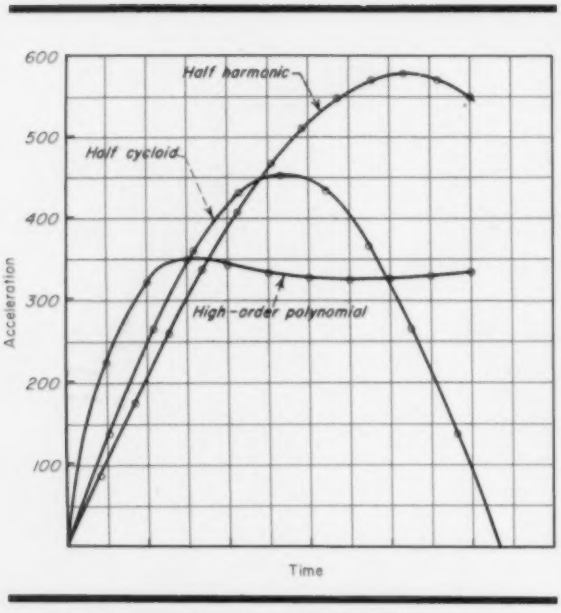


Fig. 5—Comparison of acceleration peaks between a half cycloid, half harmonic, and high-order polynomial.

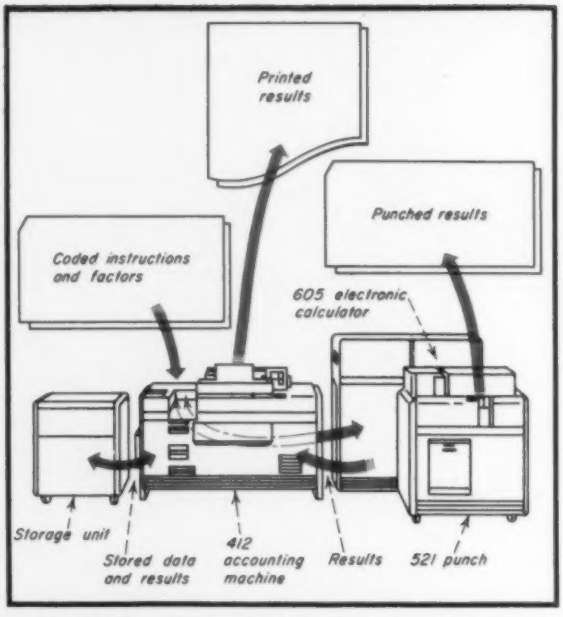


Fig. 6—Data flow diagram for the IBM Type Card Programmed Calculator (CPC). Cards fed into the accounting machine are obtained either from stored units or newly punched instructions. When the accounting machine reaches a particular operation (it is only capable of adding) it sends a signal to the electronic calculator which performs the operation and sends back the answer. The accounting machine then proceeds to the next operation. Results are either printed or punched on cards

TABLE I—BOUNDARY CONDITIONS OF A HIGH-ORDER POLYNOMIAL FOR EXAMPLE IN TEXT

	Cam Position		
	$\theta/\beta = 0$	$\theta/\beta = 0.5$	$\theta/\beta = 1$
y	0.100 in.	0.125 in.	0.100 in.
dy/dt	75 in./sec	0	−75 in./sec
d^2y/dt^2	0	..	0
d^3y/dt^3	to be determined	..	to be determined

when the velocity and the rise are specified, the ratio of maximum accelerations are:

$$\frac{\text{Half cycloid}}{\text{Half harmonic}} = \frac{\pi}{4}$$

Assuming the longer time ($6.67 + 10^{-4}$) is used, the average acceleration is found to be:

$$\beta = 6.67 \times 10^{-4}$$

$$a_{avg} = \frac{\Delta v}{\Delta t} = -112{,}000 \text{ in./sec}^2 = -291 \text{ g}$$

This indicates that there is considerable room for improvement. In other words, it should be possible to find curves with maximum accelerations of less than 457 g (and of course, more than 291 g). Therefore an equation is developed from the general polynomial equation as follows:

$$y = A_0 + A_1\left(\frac{\theta}{\beta}\right) + \ldots + A_9\left(\frac{\theta}{\beta}\right)^9 \qquad 8\text{ (A)}$$

Differentiating successively three times gives:

$$\beta\frac{dy}{dt} = A_1 + 2A_2\left(\frac{\theta}{\beta}\right) + \ldots + 9A_9\left(\frac{\theta}{\beta}\right)^8 \qquad 8\text{ (B)}$$

$$\beta^2\frac{d^2y}{dt^2} = 2A_2 + 6A_3\left(\frac{\theta}{\beta}\right) + \ldots + 72A_9\left(\frac{\theta}{\beta}\right)^7 \qquad 8\text{ (C)}$$

$$\beta^3\frac{d^3y}{dt^3} = 6A_3 + 24A_4\left(\frac{\theta}{\beta}\right) + \ldots + 504A_9\left(\frac{\theta}{\beta}\right)^6 \qquad 8\text{ (D)}$$

To avoid the necessity for assuming a value for the acceleration at the top of the rise (point D in Fig. 4) a symmetrical curve CDC' is chosen although only the first half is to be used.

Boundary conditions for Eqs 8 (A) to (D) are given in Table I. In many cases the cam angle β is specified and no further choice can be made. In this case, β is arbitrary (although between rather narrow limits), and a rule of thumb has been developed for determining β when working with this general polynomial:

$$\beta = 0.525\ (\beta \text{ cycloid} + \beta \text{ harmonic})$$

Therefore, the value for β becomes:

$$\beta = 0.525\ (6.67 + 5.24)\ 10^{-4} = 6.25 \times 10^{-4}$$

Third derivative is used as a parameter and varied until desirable values of the maximum acceleration are found. A rule of thumb for the first assumption is to pick a value such that the average acceleration is reached in one tenth of the total time. Thus:

$$a_{avg} = \frac{\Delta y}{\Delta t} = \frac{-75 \text{ in/sec}}{6.25 \times 10^{-4}} = 12{,}000 \text{ in/sec}^2 = -311\text{g}$$

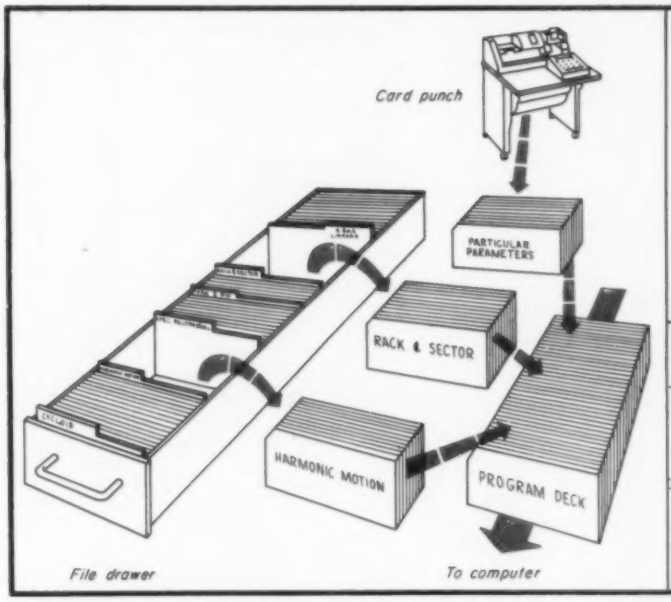
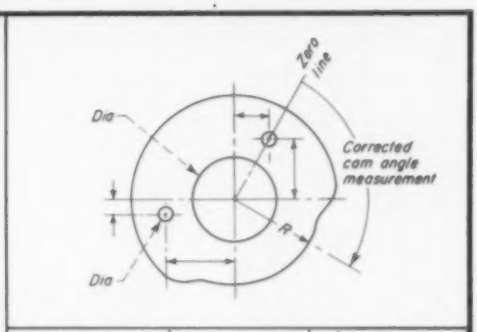


Fig. 7—Particular parameters of cam problems, such as speed and dimensions, are punched up and assembled with standard decks to quickly form the program deck.



CORRECTED CAM ANGLE DEG.	MIN	RADIUS FROM CAM SH. CTR	MACHINE TIME DEG.	MIN
180	00	23110	180	00
181	00	23110	181	00
182	00	23109	182	00
183	00	23105	183	00
184	00	23099	184	00
204	01	21708	204	00
205	01	21597	205	00
206	01	21488	206	00
207	02	21382	207	00
208	02	21280	208	00

Fig. 8—Manufacturing drawing of a cam contains radial and angular dimensions tabulated directly on the same drawing paper by a 412 accounting machine.

and for $\theta/\beta = 0$, the third derivative becomes:

$$\frac{d^3y}{dt^3} = \frac{-120{,}000}{0.1 \times 6.25 \times 10^{-4}} = -19.2 \times 10^8$$

For $\theta/\beta = 1$

$$\frac{d^3y}{dt^3} = 19.2 \times 10^8$$

Constants of the polynomial are evaluated from this starting value of the third derivative. Four of the constants are easily obtained from the given boundary conditions when $\theta/\beta = 0$. A double value of β is used to include the second half of the curve CDC; therefore $\beta = 2(6.25 \times 10^{-4}) = 12.5 \times 10^{-4}$.

From Eq 8 (A)

$$A_0 = 0.1$$

From Eq 8 (B)

$$A_1 = 75\,(12.5 \times 10^{-4}) = 9.4 \times 10^{-2}$$

From Eq 8 (C)

$$A_2 = 0$$

From Eq 8 (D)

$$A_3 = \frac{(12.5 \times 10^{-4})^3\,(-19.2 \times 10^8)}{6} = -0.625$$

The other six constants are found by setting up six simultaneous equations based on the boundary conditions of $\theta/\beta = 0.5$ and $\theta/\beta = 1$. After solving for the constants of the polynomial equation, the displacements, velocities and accelerations are obtained by evaluating Eqs 8 (A), 8 (B) and 8 (C). By repeating the process for slightly different values of the third derivative a curve having the most desirable acceleration properties can be found.

Comparison of acceleration curves between the polynomial, the half cycloidal and half harmonic curves is shown in Fig. 5. It is observed that the polynomial very closely approximates a portion of the "modified trapezoid" curve—a trapezoid with rounded corners.

No claim is made that this general polynomial with ten constants or for that matter any polynomial is the final answer to cam curve fitting. Yet some engineers have long favored trigonometric forms such as the modified trapezoid without realizing that it is easily developed from a general polynomial.

The general polynomial is completely flexible with regard to the matching of boundary or interior conditions and ideally suited for solution on automatic computing machines. For example the IBM Card Programmed Calculator (CPC) can determine in approximately 10 min the solution of the 10 simultaneous equations for the constant A_0, A_1 . . . A_9 and the evaluation of the displacement, velocity, acceleration and third derivative for twenty points between $\theta/\beta = 0$ and $\theta/\beta = 1$. Generally no more than three or four attempts are necessary to find an optimum curve and the curve fitting problem can be completed in less than an hour of computer time.

Digital Computers

The design of cams, more perhaps than any other mechanical component, involves extensive calculations. The evaluation of polynomial forms and displacement curves, "triangulation", determination of pressure angle and radius of curvature, all involve lengthy and repetitive calculations. The modern day automatic electronic computer can very easily pay for itself as a "design tool" in support of research and development engineering and is ideally suited for problems in cam design.

TABLE II—OPERATIONS PERFORMED ON A 605 CALCULATOR

Operations	Functions	
$A + B = C$	Sin A	Cosh A
$A - B = C$	Cos A	Sinh^{-1} A
$A \times B = C$	Sin^{-1} A	Tanh^{-1} A
$A \div B = C$	Tan^{-1} A	C^A
$\sqrt{A}$, $\lvert A \rvert$	Sinh A	C^{-A}

Modern computer systems, such as the IBM Card Programmed Calculator (CPC) shown in Fig. 6 have been used by the authors for cam calculations for three years. The CPC is a moderate cost, moderate speed computer, made up of standard accounting machine units. As is implied in the name, the computer obtains its instructions from standard punched cards and is capable of as many as 150 arithmetic operations per minute. Each card contains codes which refer to factors "A" and "B" in storage or on the card itself and a code which instructs the 605 calculator as to which arithmetic operation is desired. The 605 is controlled by a general-purpose control panel and upon sensing the "Operation Code" in the card, the 605 can perform any of the arithmetic operations shown in Table II in one card cycle or at the rate of 9000 per hr. The circular, hyperbolic, exponential and inverse functions are obtained automatically by the evaluation of truncated power series and average about 900 per hr.

Programming

To perform a cam calculation a deck of instruction cards (program deck) is necessary. Each card specifies one arithmetic or transcendental operation on factors which are read from storage or may be entered on the program card itself. For example, a deck of cards may perform the following functions consecutively: evaluate a motion curve at the "point of interest", compute the radius of the cam by triangulation, print or punch the angular co-ordinates and radii, increment the angular coordinate and, when run repetitively, produce a complete cam design.

Since many of the cam procedures are standardized, the program decks can be prepared permanently and stored in a file drawer as shown in Fig. 7. Any given problem can be run by assembling the proper deck from stored data and adding to it the particular conditions. A finished listing for a cam is shown in Fig. 8 as prepared by a computer except for headings. The calculation of a cam radius at a given angular location for a standard motion curve and connecting linkage takes less than 2 min on a CPC machine.

Recently IBM made available a much more powerful computer, the 650 Magnetic Drum Data Processing Machine, which is referred to as a "Stored Program" calculater because the instructions to the machine as well as the data are stored on the magnetic drum in the form of 10 digit numbers. For the 650, the program deck which runs repetitively on the CPC becomes a basic loop —a series of instructions which, once stored on the drum from punched cards, runs repetitively without further human intervention. By having both the machine instructions and the data stored on the magnetic drum, two distinct advantages are derived:

1. Instructions may be modified by operating on them in exactly the same way as upon data.

2. Card reading and card handling are greatly reduced.

Cam calculations proceed on the 650 at the rate of 1.2 sec for each angular increment. A cam which is specified in one degree increments for the entire circumference (360 points) and which involves 126 additions, 58 subtractions, 42 multiplications, 12 divisions and 125 logical operations, can be computed on the 650 computer in 7.2 minutes.

Automatic Cam Manufacture

Production of master and model cams by traditional methods is expensive and time consuming. The semi-automatic milling or grinding machine with the concomitant hand filing operation has been made fully automatic with the development of a tape controlled milling machine. Computers such as the IBM 650 and the IBM Type 046 Card-to-Tape Punch are being applied to the preparation of punched paper tapes which are used to control modified machine tools such as lathes and milling machines.

Calculations on the 650 are performed in the same manner as before except for two particulars: In Fig. 8 it is seen that "time" or "machine angle" is incremented by a constant amount. The "corrected cam angle", which is the actual angular coordinate, comes out unevenly spaced. Since some tape controlled milling machines have a table which rotates at constant speed, an iterative procedure is performed on the 650 to obtain the cam radii for evenly spaced values of the corrected cam angle. This also facilitates inspection.

To achieve the best accuracy on the cam profile, the increment in the corrected cam angle is reduced from the usual one degree to an eighth of a degree, and for some rather large cams to a sixteenth of a degree. To specify the complete cam circumference at constant increments of one sixteenth of a degree on the 650 takes about 5 hours.

EDITOR'S NOTE: This concludes the series of articles by the authors describing both the theoretical and practical aspects of six major steps in plate cam design. Previous articles were: "Selecting and Blending Profile Curves," February 1955 page 156; "Pressure Angle Analysis," May 1955 page 155; "Calculating Minimum Radius of Curvature," September 1955 page 187; "Evaluating Dynamic Loads," January 1956 page 178; and "Design of Cam Followers," September 1956 page 197.

The pressure angle is one of the most important factors in the selection of size, contour, operating speed, wear and life of the cam. The maximum value is restricted by the distribution of forces on the cam follower, as analyzed in "Limitations on Cam Pressure Angles," January 1957 page 193. Formulas, tables and nomograph for selecting the size of cam to keep the pressure angle under a specified value are given in "Minimum Cam Size as Determined by Pressure Angle," July 1956 page 141.

Maximum roller diameter of a cam follower is dependent upon the minimum radius of curvature. This relationship is given in the form of a nomograph in "Radius of Curvature of Parabolic Cams," August 1956 page 219. Included is a method for deriving the relationship for other types of cams.

The question "When Will a Cam Follower Jump" is analyzed in detail in the July 1954 issue, page 156. Factors involved are cam profile, flexibility, mass and rotating speed.

Procedure for designing power cams as distinguished from time-displacement cams is given in "Constant Torque Power Cams," February 1954 page 181.

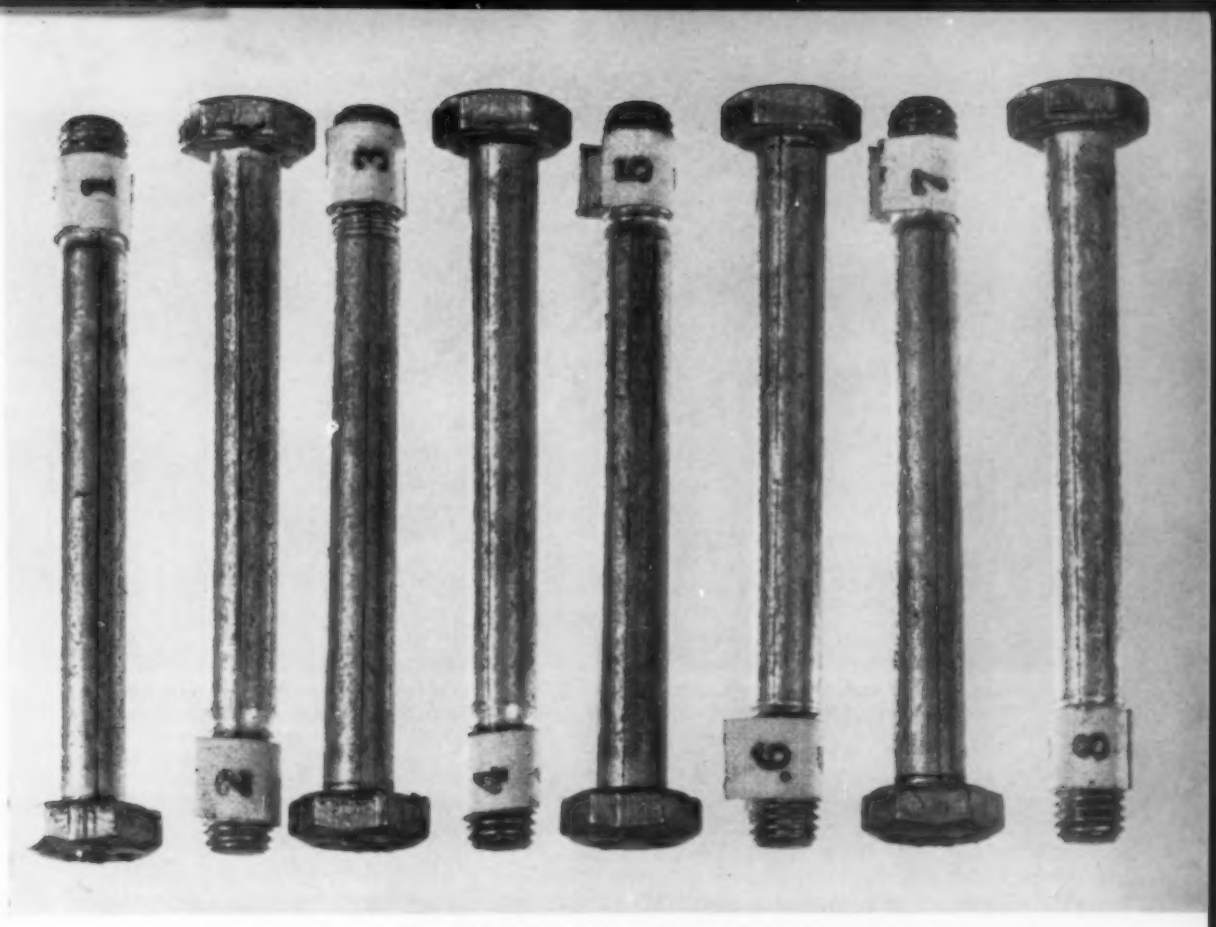


Fig. 1—Typical magnetic particle inspection indications under circular magnetization. Bolts are sprayed with clear Krylon to preserve appearance after magnetization.

Fatigue Strength of Bolts

reduced by longitudinal flaws

Fillets, circumferential cracks and thread roots are well known as sources of fatigue failure in steel bolts, but longitudinal flaws which are more difficult to find and are not readily visible, may be equally important as a source of failure.

JOSEPH VIGLIONE
Test Engineer
Naval Air Experimental Station, Philadelphia

Types of lengthwise flaws that can reduce endurance strength are seams, laps and inclusions. They arise from the quality of the steel from which the bolts are made. A seam is a longitudinal crack on a rolled surface which has been closed but not welded. A lap is a similar surface defect due to over-filling or to bending over and rolling of fins, ridges and other elevations so that surface scale is enclosed in the fold. Inclusions are metallic compounds such as oxides and sulphides entangled in the metal. Rolling extends them lengthwise. Fig. 1 shows the longitudinal flaws after circular magnetization.

To make flaws visible magnetic particle inspection with longitudinal magnetization has regularly been used to find circular flaws, but longitudinal flaws require circular magnetization for their detection, as shown in the box on the next page. While the effect of longitudinal flaws is not too well understood, it has been found that such flaws result in as much as 30 per cent reduction in number of cycles to failure.

To determine the exact influence of these flaws in reducing service life, a series of tests were conducted on bolts with no transverse defects. These tests were made on

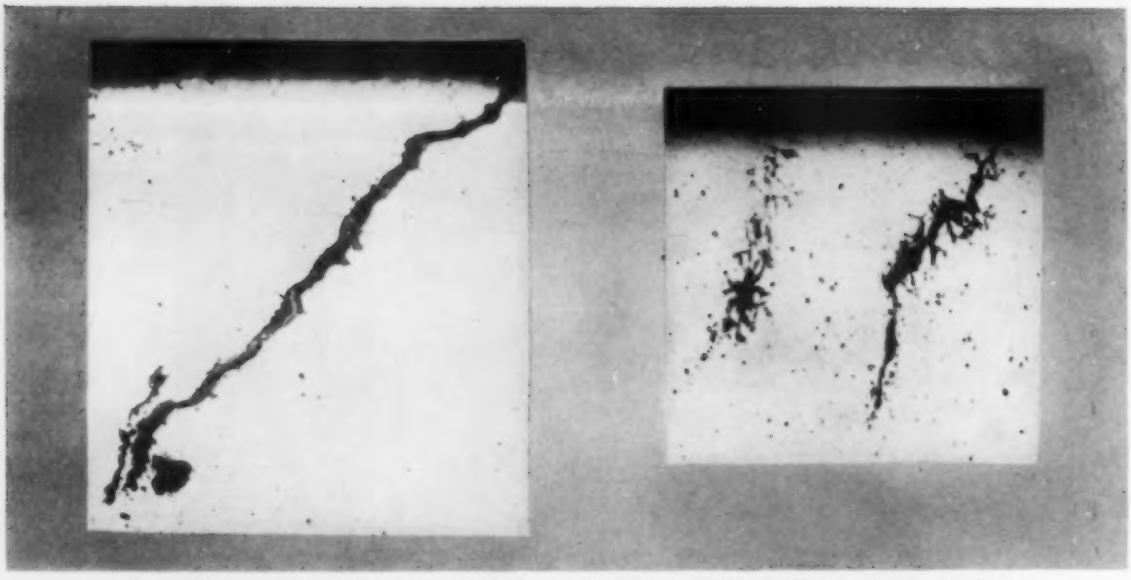


Fig. 2—Flaws after sectioning. Left, shank flaw 0.0088 in. long; right, thread flaw 0.0048 in. long. Both views at 500 magnification, from a ¼ in. bolt tested at 2300 psi which failed in 44,300 cycles.

⅜ in. and ¼ in. dia aircraft bolts purchased to MIL-B-6912. Since results were similar for both sizes only details about the ¼ in. bolts are given. These had 28 threads per inch and were 2⅜ in. long. The bolts had machined threads and were typical of those made for aircraft. Bolt material was nickel-chrome-molybdenum steel (either 8630, 8375 or 8740), heat treated to a minimum of 4080 lb ultimate tensile and 7360 lb double shear strength.

Test Loads and Procedures

A curve of stress versus number of cycles to failure was first established on a direct stress fatigue machine. From this curve two loads were chosen: the higher load was selected to produce an average life of about 50,000 cycles for sound bolts; the lower load a life of about 250,000 cycles. These tests loads were 2300 lb and 1400 lb respectively. Twenty bolts without any defects were tested at each load. This allowed a mean and standard deviation to be obtained for these tests to which other results could be compared.

Bolts with the longitudinal flaw indications as determined by circular magnetization were numbered 1 to 80, in order of decreasing severity. Twenty bolts having the worst visible defects were then chosen, and half of this group were tested at 1400 lb, the other at 2300 lb. If reduction in fatigue life was observed in this group similar tests were made on successive groups in which the defects got less severe. When a certain group had a mean fatigue life equal to that of the sound bolts the tests were considered complete.

Bolts were loaded 1100 times per min on the fatigue machine. During each cycle the tensile load varied between 10 and 100 per cent of maximum. The machine had been calibrated statically and dynamically to evaluate the inertia effects occurring during the operation of the machine and results have been corrected for such effects.

All fatigue failures were in threads and related to the flaws. Results, therefore, show the possible general effect of longitudinal flaws on the fatigue life of similar bolts. Table I shows the mean number of cycles to failure for the two test loads.

Inspection of Bolts After Tests

After the tests some of the bolts were sectioned as shown in Fig. 2 to determine depths of flaws at point of failure by microscopic examination. This was done to correlate fatigue life to flaw indication at the thread and shank. Flaws at threads cannot be readily detected by magnetic particle inspection.

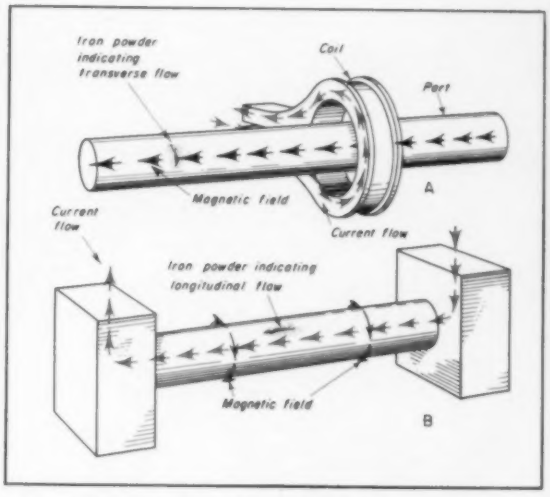
Because of the time and effort that would be involved in sectioning all the defective bolts tested, only three or four bolts were sectioned from each group. The examination disclosed, in general, that depth of flaw was less when the visual defect indication was less severe. This was further corroborated by a statistical analysis which established that there was a tendency for the greater visual defect appearance to be associated with greater depth of discontinuity.

In bolts sectioned, however, there appeared to be no direct relationship between fatigue life and depth of discontinuity for individual bolts. Presence of flaws, however, did affect significantly the life of bolts in the aggregate as shown by statistical analysis of results.

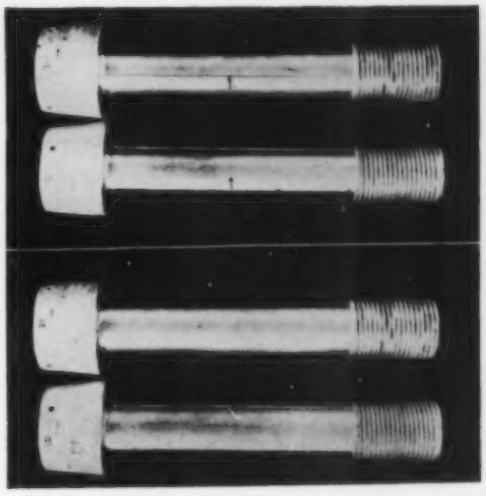
Five each of sound and defective bolts were given static tensile tests, selecting widely different degrees of flaws. This was done to ascertain whether any appreciable differences existed between the average ultimate tensile strength

TABLE 1—NUMBER OF CYCLES FOR FAILURE

Test Load	Sound Bolts	Defective Bolts	
		Mild Flaws	Severe Flaws
1400 lb	250,000	185,000	175,000
2300 lb	49,000	48,000	35,000



The same pair of bolts under circular magnetization (top) and longitudinal (below). Longitudinal flaws show clearly when circularly magnetized; not at all when longitudinally magnetized.



For longitudinal magnetization (top), part is placed inside a coil carrying electric current. Circular magnetization (bottom) is produced by passing current lengthwise through component.

Magnetic Particle Inspection

Mechanical components which are subject to high stresses frequently develop cracks which are invisible to the eye. In other cases faults are present even before use. In order to detect the presence of these faults magnetic particle inspection offers a quick and reliable method applicable to magnetic materials.

The method is based on the principle that irregularities in a magnetized part (such as cracks and nonmetallic inclusions at right angles to the magnetic lines of force) cause changes in the path of the magnetic flux which result in flux leakage and interfere with magnetic lines of force.

The interference is detected by the application of very fine particles of magnetic material, either blown or flowed in a liquid suspension over the part to be inspected. These particles tend to pile up, cling and bridge over such discontinuities. This gives a clear indication of the location, extent and shape of the flaw. A surface defect is indicated by a clean line of the particles following the outline of the crack, and a subsurface defect is shown by a fuzzy collection of the magnetic particles on the surface above the defect.

Longitudinal Magnetization

Transverse (crosswise) flaws are found by magnetizing the part lengthwise. A magnetic field running lengthwise is created within the part by placing it inside a coil carrying electric current. Iron powder is attracted and held wherever this field cuts across a crack, as shown at (A). Flaws are thus made quite visible where previously they could not be seen.

Circular Magnetization

Longitudinal flaws are shown by a magnetic field created circumferentially by passing electric current lengthwise through the part, as shown at (B). Flaws are revealed by the same method as above, but only longitudinal flaws will be indicated as shown in the illustration. Sensitivity of the test can be controlled to any predetermined need. Minor flaws thus need not be revealed unless so desired.

of the sound and defective bolts. No difference was found.

Results of the fatigue tests indicate that defective bolts, with either longitudinal or transverse flaws, should not be used where maximum resistance to fatigue failure is essential. Also, to detect both types of flaws, it is necessary to subject the bolts to both longitudinal and circular magnetization.

EDITOR'S NOTE: Previous articles in *Product Engineering* on fatigue failures include:

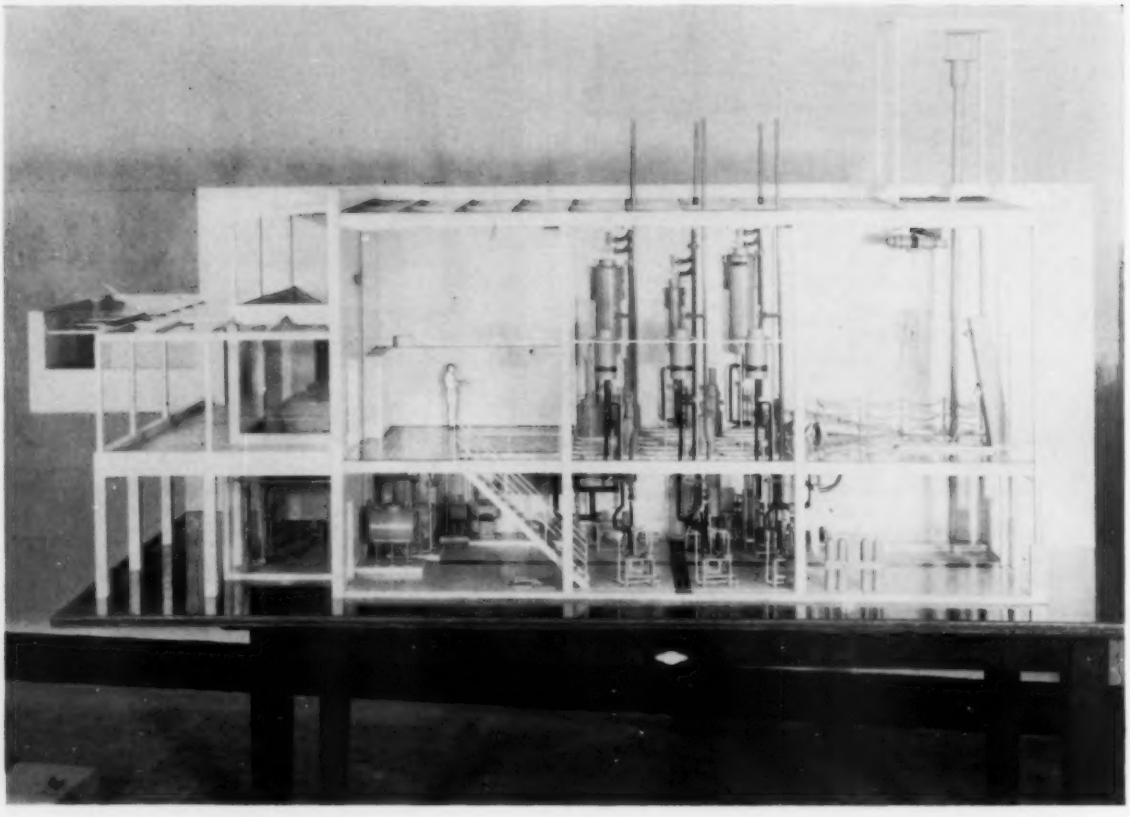
"How to Prevent Fatigue Failures," October 1955 page 175, a practical, non-metallurgical discussion of causes of fatigue failures, such as surface finishes and coatings, fillets, temperature and corrosion.

"Predicting Fatigue Failures of Notched Specimens," April 1955 page 177, suggests that stress raisers may be more readily understood if considered as strain raisers.

"Improving Fatigue Resistance of Bolted Joints," April 1953 page 190, gives data on materials, bolt design, surface finish and assemblies.

"Fatigue Testing—Its Machines and Methods," February 1953 page 128 and March 1953 page 148, covers practical considerations in fatigue testing, including a general approach to the problem and descriptions of the types and operating principles of some typical testing machines.

Opinions expressed are those of the writer and are not to be construed as official or reflecting the views of the Navy Department or the Naval Service at large. Photographs are official U. S. Navy.



Reactor Conditions Simulated In New Test Facility

Mechanical mechanisms and components to be used in pressurized water nuclear reactors can be tested in a new test facility (model above) which was designed to duplicate temperature, pressure, and water purity conditions found in an operating reactor. However, no radioactive source material will be used.

The test facility was built as a commercial venture by the United Shoe Machinery Corp. (USMC) in Beverly, Mass., and is presently being used to supply information to be used in the design of control drive mechanisms for a submarine type reactor. These assembled control drive mechansims then can be tested in the facility in an environment which duplicates that found in a pressurized water reactor. Equipment is also available to test fuel handling systems.

Such environmental testing is necessary in order to determine the effect on such components as bearings, springs, pivot pins, lead screws, nuts, and materials when exposed to the high temperature and pressure of a pressurized water reactor. Components can be placed in autoclaves (smallest 1 gal, largest 100 gal) and tested for crevice corrosion effects, wear, torque build-up, and endurance under controlled water conditions.

Although the test facility was developed to include the necessary tests connected with government contract programs, considerable flexibility has been factored into its design to extend its uses. The equipment consists of nine complete test systems, each with its own flow control and instrumentation. Half of the autoclaves are for 600 psi testing, and the rest for 2500 psi testing. The largest of these units is 13 ft long. Maximum test temperature attainable is 600 F.

With the facility's instrumentation, it is possible to check the conductivity of the water at different places in the system, and indicate the temperature in 48 positions and record them in 20 more. The circulating water can be continuously filtered and demineralized and it is possible to inject and control certain chemical additives into the systems for special tests.

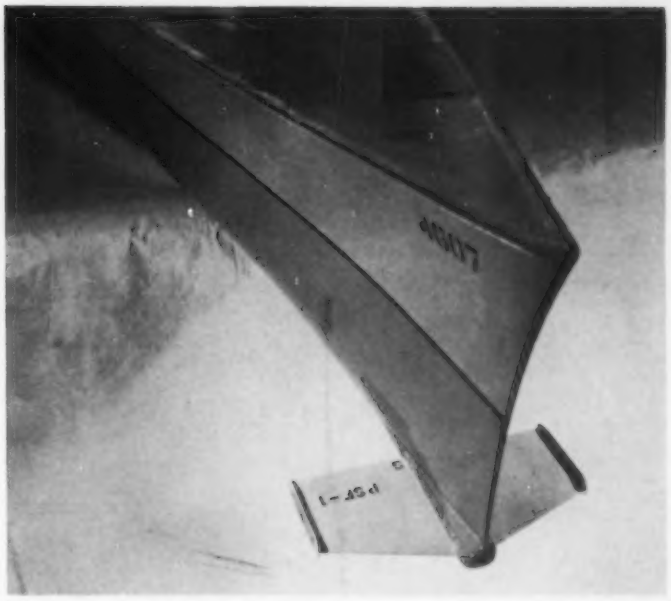
Bow Fins Reduce Ship's Pitching Motion

With anti-rolling fins already a reality on several ocean liners, studies are now under way on the feasibility of anti-pitching fins, right. Tests have been made on ship models at the Navy's David Taylor Model Basin, just outside Washington, D. C., and the results are favorable. In the near future the Navy hopes to be testing the anti-pitching fin on a Mariner Class merchant ship.

The new anti-pitching fin will be located at the fore-foot of the ship and will be fixed. This is unlike the anti-rolling fins (right, bottom), which are located on the side of the hull about midship, and are controlled with elaborate machinery. The planform area of the anti-fin is usually given as a percentage of the water line area of the ship. Model tests have been conducted with the area of the fin about 2.0 per cent of this water plane area. On the Mariner Class vessel, this will make the dimensions of the fin on one side of the ship about 15 ft in half-span, 29 ft in chord at the hull, and 19 ft at the tip.

The data derived from the tests are applicable to specific forms and test conditions, and are too few to generalize. For example: on a ship 500 ft long moving at 17-20 knots in waves 400-500 ft long (crest to crest), pitching of the ship equipped with anti-pitching fin is 30-35 per cent less than it is without the fin; in wave lengths of 200 ft, pitch reduction effectiveness of the fin is dropped to 20-25 per cent. Also, the fin was not found to be too effective in long waves at low speeds.

The important effect of the fins is to keep the fore-foot of the ship in the water when high waves are encountered, thus maintaining the damping effect and eliminating ship slamming. With respect to damping, it has not been determined whether the effect of the fin is due to the dynamic lift on the surface of the fin, or to the fin's vertical drag.



ANTI-PITCHING FINS attached to the hull of one of the models tested at the David Taylor Model Basin. "Fences" on the tip of the fins prevent the formation of a swirling motion of the water on the fin tip. On the downward stroke, these strong vortices are formed at the leading and trailing edges of the fins. When the fins approach the surface of the water, these vortices slap the side of the ship. At present, tests are too few to allow general conclusions to be drawn with respect to the effects of fin area.

ANTI-ROLLING FINS on the Navy's experimental ship Compass Island, the forerunner of a fleet of nuclear powered ballistic missile launching vessels. Equipped with a wide assortment of navigation instruments, its purpose is to evaluate new inertial aids for precise mid-ocean navigation, and to speed up the launching of the Fleet Ballistic Missile. A converted Mariner-class cargo vessel (like that being tested with the anti-pitching fins), the Compass Island will roll less than one-tenth of much as other Mariner-class vessels in the same seaway. The Sperry Gyrofin stabilizers are controlled automatically from the bridge by instruments measuring roll rate, angle, and acceleration. The anti-roll signals are transmitted to hydraulic actuators which directly operate each fin shaft. The fins may be retracted into recesses in hull when not in use.

The reduction of pitching motion of the model using fins of different configuration was about the same, and it was shown that an increased fin area would increase the fin's effectiveness. However, when designing the fins, other aspects must be considered. For example: on the downward stroke, strong swirling action of the water is formed at the leading and trailing edges of the fins. This adverse condition is reduced to a great extent by tip fences. When the fins approach the surface, these vortices escape into the air and slap the side of the ship's hull. A fin of narrower span will increase the severity of the impact. The severity could be decreased by increasing the forward speed of the ship, but the speed necessary to accomplish a significant reduction is presently unattainable. The condition was improved by transverse slots in the fins, and further by holes at the leading and trailing edges.

In calm water the effect of the fins is an additional 10-15 per cent resistance. In rough seas, however, the resistance is decreased because of the reduced pitching of the ship. Consequently the fuel and power required to maintain a prescribed speed is reduced.

Some experimental work with antipitching fins was carried out on the Holland-American Line vessel Ryndam. The fins were installed at the bow of the ship not far below the load waterline. Transverse vibrations were so severe that after two days the fins had to be removed.

Studies are underway on activated bow fins. Greater pitch reduction might be obtained with a small activated fin than with a large fixed fin.

First Silicon Plant

The E. I. du Pont Co. will build the country's first full-scale plant for the production of hyper-pure silicon at Brevard, North Carolina. Operation is scheduled for early 1958, and the plant is expected to produce about 50,000 lb of semi-conductor grade silicon annually. Present selling price of the material is $320 a pound.

The Brevard plant will also have an annual capacity of 20,000 lb of "solar-cell" grade silicon which sells for $150 a pound. Du Pont is the nation's only producer of silicon.

Foreign News Briefs . . . .

Birmingham, England—A British firm, James Booth & Co., of this city, says that it is now producing controlled stretched duralumin plates, previously available only from the U. S. Prime user is a British aircraft concern. The plates were made by a special process combining both forging and rolling operations, to insure uniform mechanical properties. The largest plates delivered were 25 ft 4 in. long, 2 ft 8 in. wide, and 2 in. thick. However, the company says that it can supply plates up to 35 ft long if required, but subject to a max cross-sectional area of 65 sq in.

Bonn, Germany—According to preliminary estimates of the Association of German Machine Tool Builders, West German machinery production reached a total value of about $4.18-million out of which about $1.4-million were exported. This means an increase in production value of 18 per cent and an export increase of 23 per cent over 1955. The number of employees rose from 740,000 at the end of 1955 to almost 800,000 at the end of 1956. Orders on the books dropped slightly during the same period. As a consequence of recent domestic credit restrictions which resulted in an investment decrease, many builders had to concentrate more heavily on exports.

London, England—Molybdenum disulphide and a modified form of bentolite clay are the base materials of a new series of greases developed in Britain for high temperature operation. The greases are reported to be capable of giving efficient lubrication at working pressures of 100,000 psi, and can be used in machines operating continuously at 450 F. The composition can be varied to meet special operating conditions, such as high temperatures, or applications where petroleum compounds must be avoided. Makers are: Rocol Ltd., Swillington, Yorkshire, England.

Bonn, Germany—Energit-Werke, Renningen, near Stuttgart, has developed rust-proof brake-linings by adding a small amount of a chemical to the normal ingredients such as steel wool, asbestos, resins, etc. It remained rust-free after exposure for 8 hr to a moisture saturated atmosphere of 120 F. Other tests showed that the new linings helped reduce the rusting tendency of the drum rotor.

USSR—According to a recent issue of a Russian technical journal *Zavodskaya Laboratoriya*, a new method has been developed for separating tantalum from titanium. The process depends on the use of organic solvents to separate out the tantalum. It is said to have an advantage over the conventional precipitation with tannin process normally used. Complete separation of the tantalum from the titanium can be achieved within a few hours. This is true even when niobium is present. The solvents used were fluoride compounds to which cyclohexane had been added, in a solution of sulphuric acid.

London, England—A supersonic airliner capable of crossing the North Atlantic in four hours is being considered by a group of British aircraft manufacturers. A research project on the airliner already is under way in collaboration with the national airlines and government establishments. Included in the project are Bristol Aeroplane Co.; De Havilland Aircraft; Vickers-Armstrong; Rolls-Royce; A. V. Roe; Short Bros. and Harland; and Handley Page.

Ever since Britain lost its lead in the jet airliner market following the crashes of the De Havilland Comet, the industry has been talking about jumping to a supersonic airliner, conceding the current big jet market to Boeing and Douglas. The huge outlay of money for the research and development of a supersonic plane is considered beyond the capacity of any single firm in the British industry. Much of the experience in designing such an aircraft would come from the supersonic bomber project now under way at Avro. Target date for the first flight would be about 1965.

Although this is the first official announcement of such a project on either side of the Atlantic, U. S. aircraft manufacturers also have plans for such planes.

(LEFT) Complete semi-automatic welding machine showing the wire supply mounted on a separately operated motor driven rotating assembly. The transparent tube carries the flux-gas. Flux hopper is at top, holding 25 lb, an 8 hr supply. (ABOVE) The welding wire and flux come out of the torch nozzle when the torch handle control switch is pressed. When the welding current is flowing the flux is attracted to and coats the wire. Flux feed rate is adjusted by rotating the hopper. Made by Linde Air Products Co., Div. of Union Carbide and Carbon Corp., 30 East 42nd St., N. Y. 17, N. Y.

Continuously Fed Welding Wire Electrode Has Magnetically Coated Flux

A bare wire electrode of common steel composition is continuously fed from a 300 lb capacity pack through a flexible tube to the torch with Linde Air Products Company's new Unionarc welding machine. Either $\frac{3}{32}$ or $\frac{1}{16}$ in. welding wire, magnetically coated with flux and shielded in a gas atmosphere is used. A manual arc welding process, weld metal can be deposited 50 to 100 per cent faster than with covered electrodes on most downhand welding applications; and 2 to 3 times greater than covered electrode vertical or overhead welding. Welding costs are said to be 20 to 50 per cent less than with covered electrodes.

Magnetizable flux in a dispenser and fed through a flexible tube to the torch in proportion to the amount of wire that is being fed. The flux surrounds the welding wire as it is fed from the contact tip of the torch, and a magnetic field is established around the extended portion of the wire. The flux is attracted toward the exposed wire and coats it. The dispenser can be adjusted to feed different flux-to-wire ratios, but the usual ratio is between $\frac{3}{4}$ to $\frac{1}{2}$ lb of flux per pound of wire. This predetermined ratio is automatically maintained regardless of the rate of wire feed.

The flux is fluidized at the dispenser in a stream of welding-grade carbon dioxide. The gas carries the flux to the torch suspended in the gas stream. A 4-way gas solenoid valve, a check valve and a powder pinch valve make up the powder dispenser control elements for the gas flux stream. The gas solenoid valve is electrically controlled with a two-button torch switch, and whenever welding is stopped, the machine is ready to deliver a gas-flux mixture to the torch as soon as the welding starts again.

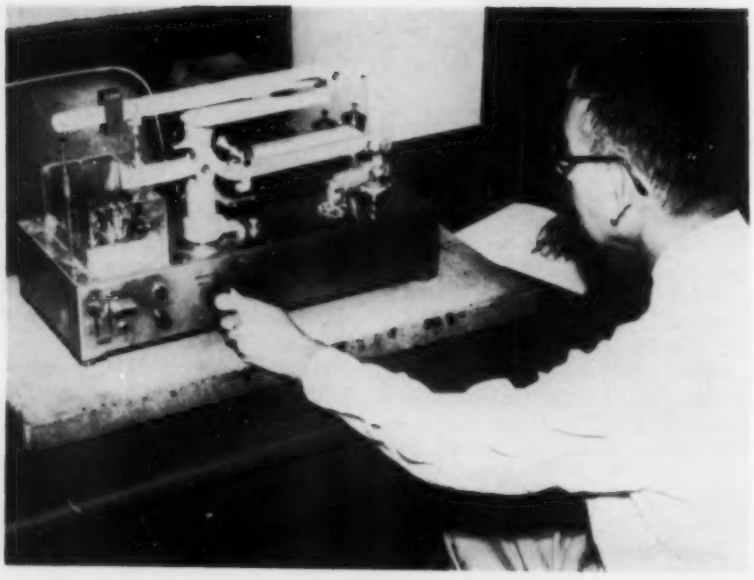
Tests were made on steels whose properties represent the carbon and deoxidation variations of at least 75 per cent of the mild steel fabricated in this country, such as ASTM class: A7, A201, A212, A283, and A285. The plate had normal mill scale or rust and the joint edges were prepared by oxygen cutting. There was no pre-weld preparation, such as grinding or wire brushing. The welds met the requirements of paragraph UW51 of Section VIII, ASME boiler and pressure vessel code.

In Multi-layer welds, some of the mechanical properties were: yield strength (0.5 per cent offset), 66,000 psi; ultimate tensile strength 78,000 psi; elongation in 2 in., 28 per cent; reduction of area, 65 per cent; weld hardness, 75-85 Rockwell B.

D-C reverse polarity is preferred. With $\frac{3}{32}$ in. wire, welding currents are usually between 350 and 450 amps. With $\frac{1}{16}$ in. wire, welding currents range from 125 to 250 amperes. Cost of the machine, with welding torch, gas regulator, hose, and control cables is about $2,400.

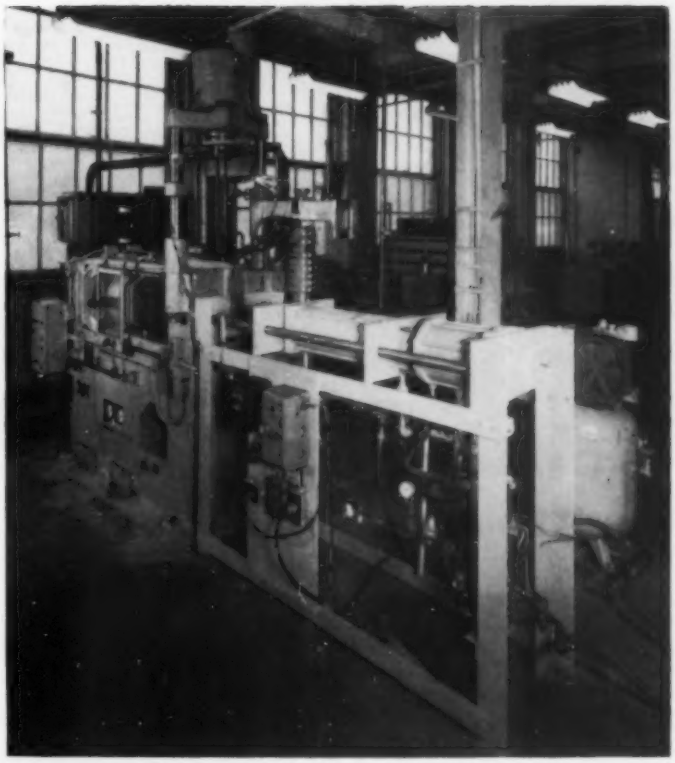
THE NEWS IN PICTURES

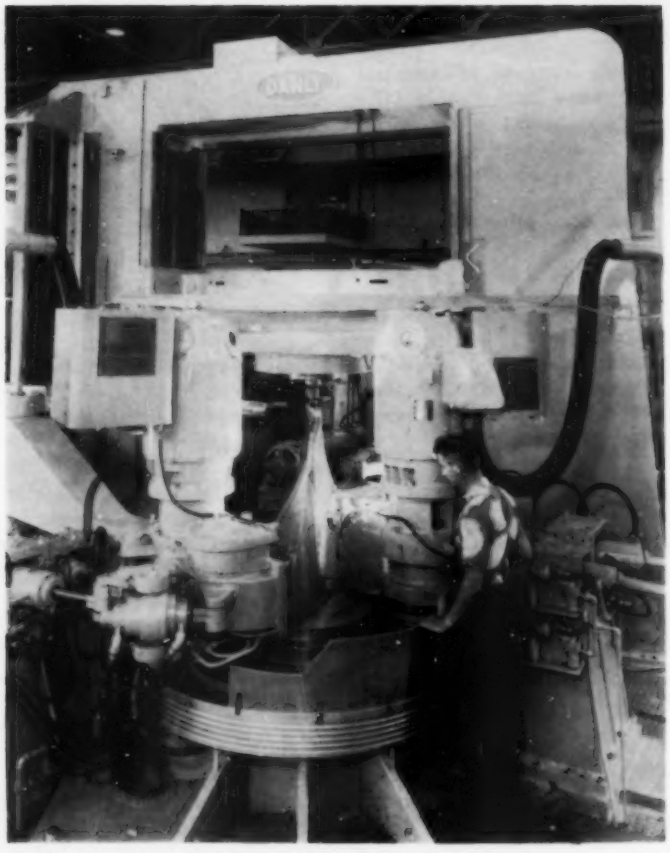
THE ASSEMBLED AND COLLAPSED XROE-1, the Marine Corp's one-man helicopter which was designed to be collapsed into a small package for easy transportation or parachute drop and quick assembly. Developed by Hiller Helicopters of Palo Alto, Calif., it weighs less than 250 lb and is powered with a Nelson 4-cylinder opposed, 2 cycle aircooled gasoline engine made by Barmotive Products, Inc., San Leandro, Calif. The rotor is 18 ft in diameter. The entire craft is held together by quick release pins (below) and may be assembled by one person in less than 10 minutes.



SPECIFICALLY DEVELOPED to measure the hardness of organic coatings on bottle crowns and cans, and on lug and continuous thread closures, this instrument is reported to have a wider application in the field of metal coatings. The device is simple to operate and eliminates the possibility of the human failure factor. The instrument has a stylus which rests on the surface of the sample being tested. The stylus is connected by an electronic circuit to a thyratron tube. In operation, a spool-shaped weight is applied in gradually increasing degrees to the stylus. If the weight is sufficient to cause the stylus to pierce the coating and establish contact with the metal of the specimen surface, the thyratron tube closes a relay. The resulting figure indicated on the scale represents the number of grams of weight required to break through the coating. Originally developed by Crown Cork & Seal Co., Inc., Baltimore, Md., for its own use, the instrument is now being manufactured under a licensing agreement by Gardner Lab., Inc., of Bethesda, Md.

WHILE THERMOPLASTIC MATERIALS are easy to handle by injection molding, thermosetting plastics are not. Any continuous supply of material to the mold is limited by the possibility that the material will cure in the system outside the mold and clog the passage to it. At Westinghouse Electric Corp.'s Materials Engineering Dept., Box 2278, Pittsburgh 30, Pa., a standard injection molding machine has been modified to permit thermosetting molding compounds of a putty-like consistency to be molded in a continuous automatic cycle. Enough material is contained in a cylinder to mold 25 to 50 pieces before recharging. The end of this cylinder is in contact with the hot mold only during the injection period, and sufficient heat is not transferred to the cylinder to set up the material in the cylinder nozzle. A typical molding cycle, timed to run to completion is: closing the mold; moving the injection cylinder against the mold sprew; injection of material into the mold; dwell time to permit the sprew to cure; retracting the injection cylinder from contact with the hot mold; curing time to complete the cure; opening of the mold and ejection of the piece.





THE SHAPE OF an airplane's wing or the blades of an axial flow air compressor can be generated with this airfoil milling machine. A wooden pattern (in the background) four times the size of the workpiece, is mounted vertically on a circular revolving table, when two large tracer wheels held in contact with the pattern transmit the relative motion to the two cutters. The machine, made by the Danly Machine Specialties, Inc., 2100 S. Laramie Ave., Chicago 50, Ill., for the NACA's Arms Lab., at Moffett Field Calif., is fully automatic once the workpiece and pattern have been put in place. It is capable of machining a shape 18 x 18 x 96 in. long or 6 x 26 x 96 in. long. For cutting alloy steels a speed range of 78 to 785 fpm is available; for aluminum alloys speeds between 3140 fpm are available. Accuracy is ± 0.004 in. over a 24 in. chordal length. The mechanism for holding the metal blank to be machined can exert an upward thrust of 8500 lb.

TECHNICAL NEWS

Fastest Production Sports Car

An apt member for the popular and ever growing "Where Are You Going to Drive That Around Here" club, the above two-seater version of Britain's 187 mph LeMans "D" type Jaguar has been specially developed for the American market. According to reports, it is in response to an increasing demand for sports cars suitable for "normal touring purpose" but eligible to enter sports car racing events in the USA. The original version was banned from these events.

Called the XK "SS" it becomes the fastest production sports car in the world. The general construction and mechanical specification of the racing version are retained, but the top speed drops to 170 mph because of added wrap-around windshield. The 3½ liter, 6 cylinder engine develops 250 hp at 6000 rpm. The bmep has been raised to 174 psi, and the pressure ratio to 9:1. Fuel consumption is rated at 25-30 mpg at 80 mph.

Total weight of the car is 2000 lb, and only the racing version of the Ferrari tops its power-to-weight ratio of 280 hp per ton. The frame is of semi-monococ construction with a central stress carrying tubular steel frame. Center body skin is also stressed. Torsion bar suspension is used all around, plus Dunlap disk brakes, with a pad life of 30,000 miles. Production of the car will be limited, and deliveries are for export only. Price in the USA: about $7000.

News Briefs . . . .

The average 1957 passenger car uses 10 per cent more aluminum than the 1956 models. On the basis of auto production forecasts for a 6.5-million car year, passenger car applications should consume 23.5 per cent more aluminum than was used in the 1956 models. The average-per-car figure has increased from 29.6 lb in 1955 to 34.6 in 1956, and on the basis of early figures, 38.1 lb in the 1957 car. Aluminum trim applications in natural and color finishes have moved up in a few years to where more than 30-million pounds of the metal are scheduled for the 1957 models. The largest single aluminum application is in automatic transmissions now utilizing 41.1 per cent. Engine components account for 32.6 per cent, and power brakes and steering take 7.3 per cent.

Testing aircraft and missiles in an airflow of 10,000 mph and 9000 F for periods of time heretofore unattainable is being developed at Cornell Aeronautical Lab., Inc., Buffalo 21, N. Y. The facility will be able to operate at extreme temperatures and speeds of hypersonic flight for periods of 15 sec or greater. Formerly, these high temperatures and hypersonic air flow could be produced for only a few thousandths of a second. This makes studies of materials and structures of short duration. The new test device will use air as a test gas, which permits the lab to accurately simulate actual flight in the earth's atmosphere.

Now being marketed in experimental quantities is Irrathene SC, a semi-conducting irradiated polyethylene film. A carbon black loaded polyethylene with an electrical resistivity between a true insulator and a true conductor, its development was made possible by the ability of irradiation to overcome the embrittlement of polyethylene when large amounts of filler are loaded in it. The material has been designed to replace such materials as graphitized fabrics and rubbers. Some properties are: yield strength, about 1800 psi; tensile strength, about 2000 psi; elongation, min 100%; specific gravity 1.05; electrical resistivity 1000-7000 ohms/square. Irrathene SC has greater resistance to chemicals and oxidation than ordinary polyethylene. General purpose grades are available in tape or film in widths from ½ to 12 in., and in thicknesses of 0.002 in.; 0.005 in.; or 0.010 in.

An opinion poll of the American atomic energy industry conducted by the Atomic Industrial Forum, Inc., has shown that the lack of economic incentive, inadequate insurance protection, and secrecy policies of the government are considered to be the three main factors limiting the development of atomic energy for peaceful purposes. These three main factors were followed closely by: lack of trained manpower; and government administrative policies and practices other than secrecy. Of the respondents to the poll, 43 per cent were manufacturers, 14 per cent were construction-engineering firms, and 13 per cent were utility companies. The remaining 30 per cent included many other interested groups.

Cyril Bath Co. has developed a machine that replaces five single purpose machines for producing the outer case of a dishwasher. Under way is a second machine that will produce the outer case for a television set. Both are produced from a single sheet of steel in a continuous process. A piece of cut-to-size sheet steel feeds into one end, and comes out as a completely formed outer case, with holes properly punched, flanged, etc.

COMING EVENTS

MARCH 11-15

The 1957 Nuclear Congress, Convention Hall, Philadelphia, Pa. Expected to attract engineers and scientists from all over the world, the Congress has as its purpose, the promotion of the use of atomic energy for peaceful purposes in all the nations of the world. The 5th Atomic Energy for Industry Conference will be held in conjunction with the Congress. Over 200 exhibtiors will display equipment. In the engineering and science sessions will be 130 technical papers dealing with all phases of nuclear operations. Emphasis will be on new developments of potential value to civilian industry, especially in the field of metallurgy, chemical processing, and mechanical and power applications.

MARCH 12-20

Quality Control by Statistical Methods, a basic course to be conducted at the Georgia Institute of Technology. For further information write to Coordinator, Short Courses & Conferences, Georgia Institute of Technology, Atlanta, Georgia.

MARCH 13-15

Spring Meeting of the National Fluid Power Association, Hollywood Beach Hotel, Fla.

MARCH 18-21

SPI Annual National Conference and Pacific Coast Plastic Exposition, Los Angeles, Calif. Sessions will be held at the Hotel Biltmore on plastics in the fields of electronics, aircraft and defense, packaging, building materials, appliances, sheet and cellular plastics, in addition to the latest developments for processes and processing. The Exposition will be held at the Shrine Exposition Hall.

MARCH 18-21

Military Automation Exposition, Trades Show Bldg., New York City. Exhibitors will be chiefly manufacturers and suppliers of components, subassemblies and manufacturing equipment used by the military or manufactured by prime contractors to military specifications. No classified items will be shown. Nearly half of the equipment to be exhibited will be electronic. Instrumentation will be emphasized.

MARCH 18-21

Institute of Radio Engineers, National Convention and Radio Engineering Show, Waldorf-Astoria Hotel and the New York Coliseum, New York City. A program of 55 techincal sessions is being set up by the committee; 33 sessions will be held at the Waldorf and 22 at the Coliseum. Two highlight sessions, "Future Use of Air Space" and "Microminiaturization—The Ultimate Technique" will be held on March 19th.

MARCH 18-21

Second National Conference of Gas Turbine Div. of the ASME, Sheraton-Cadillac Hotel, Detroit, Mich. Representatives of European automobile manufacturers and the big three of the U.S. will discuss the use of gas turbines for automotive use. Other papers will be on the use of gas turbines for aircraft, ship propulsion, industrial power generation, and chemical and nuclear plants. Exhibits will show the latest developments in gas turbines.

MARCH 25-27

American Society of Tool Engineers, Silver Anniversary Technical Meeting and Convention, Shamrock Hilton, Houston, Texas. Will have symposiums on Ceramic and Plastic Tooling, technical papers and panels.

MARCH 25-29

10th Western Metal Congress and Exposition, Pan-Pacific Auditorium, Los Angeles, Calif. The Congress will be held in the Ambassador Hotel. To be held simultaneously by ASM's Metals Engineering Institute is a Titanium Conference. It will be an up-to-date repeat of the first one given at the university level two years ago in cooperation with New York University. Titles of daily discussions during the week are: "Applications, Design and Cleaning"; "Forming"; "Machining"; "Welding and Brazing"; and "A Look Into the Future."

MARCH 27-28

ASME Management Conference, Hotel William Penn, Pittsburgh, Pa.

APRIL 1-2

5th Midwestern Conference on Fluid Mechanics and the 3rd Midwestern Conference on Solid Mechanics, held concurrently at the Univ. of Michigan, Ann Arbor, Mich.

APRIL 7-10

ASME Instruments & Regulators Conference, Northwestern University, Evanston, Ill.

APRIL 8-10

ASME Spring Meeting, Dinkler-Tutwiler, Birmingham, Ala.

APRIL 8-12

5th Welding and Allied Industry Exposition, Convention Hall, Philadelphia, Pa. Held concurrently will be the National Spring Meeting of the American Welding Society. A total of 18 sessions are planned: welding problems in the design and fabrication of nuclear reactors and reactor components; effect of neutron radiation on weldability and mechanical properties of structural metals; welding of titanium and zirconium; brazing stainless steels and high temperature alloys; zinc soldering of aluminum; and others.

APRIL 9-10

First Annual Conference on Electronics in Industry, Illinois Institute of Technology, Chicago, Ill. Sponsored by the IRE Professional Group on Industrial Electronics, and the Armour Research Foundation. Some of the papers will be: Economic and Technical Aspects of Industrial Electronics; Principles and Techniques for Direct Reading Digital Transducers; Application of Magnetic Amplifiers in Industrial Instrumentation and Control; Automatic Card Programmed Control of Reversing Rolling Mills; Solid State Devices in Industrial Electronics; Selecting Reliability Levels in Equipment Design.

APRIL 11-13

Southwestern IRE Conference and Electronics Show, Shamrock Hilton Hotel, Houston, Texas.

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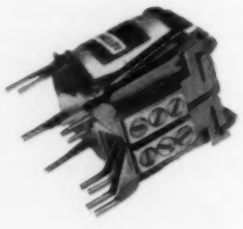
This is no isolated example. Exhaustive tests prove that all our raw material is equally fine. It's one of the many reasons why Automatic Electric relays enjoy far longer life.



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GENERAL TELEPHONE SYSTEM

Standardized Method for Constructing Nomographs

CARL P. NACHOD
Nachod & U.S. Signal Co., Inc.

This system for constructing nomographs uses the same scales and layout for solving any equation involving multiplication, division, raising to a power or extracting roots. Excluded are equations involving addition, subtraction or trigonometrical functions.

The method is the analog of the slide rule—the sliding rule being replaced by lines drawn across three scales. Like the slide rule, the nomograph does not ordinarily indicate the position of the decimal but has the advantage over the slide rule in that a graphic record of the operations remains to facilitate checking.

Furthermore, basic nomograph forms can be run off on a duplicating or blueprint machine whenever needed. No further construction of scales is required once a master copy has been prepared. Thus, instead of graduating a number of logarithmic scales through one or more moduli, as is the usual method of constructing nomographs, it is only necessary to draw the required secants across the same three scales of a pregraduated form.

This blank form has three parallel, equi-distant scales. The outer ones, X and U, are graduated logarithmically from 1 to 10, the inner scale, Z, from 1 to 100. Any line drawn across all three, Fig. 1, cuts the scale Z at the product of X and U, i.e., $z = xu$. Note that the scales are designated by capitals and the points on them in lower case letters. These points, not the scales, are marked as the constant or variables of the equation.

The essence of the system is a Vee with its point on U and intersections on X and Z. In Fig. 1 on X and Z, a and b are diagonally opposed, as also are d and c. On every Vee these are so disposed—

Since

$$\begin{aligned} z &= xu \\ au &= c \\ du &= b \\ ab &= cd \end{aligned}$$

and if

$$\begin{aligned} x &= u \\ z &= x^2 \end{aligned}$$

So that squares applied to the z scale have their square roots on X or U. Any inverse is found on an outer scale by a secant from the other outer scale through 10 (for 1) on Z. Example: a secant from 5 on X through 10 on Z cuts 2 on U. Pointed off, the inverse of 5 is thus 0.2.

The quantities in an equation to be solved will generally be disposed on the X and Z scales. There are four possible positions for the quantities, and the constant is treated as one of

(continued on page 217)

Standardized Nomograph Construction

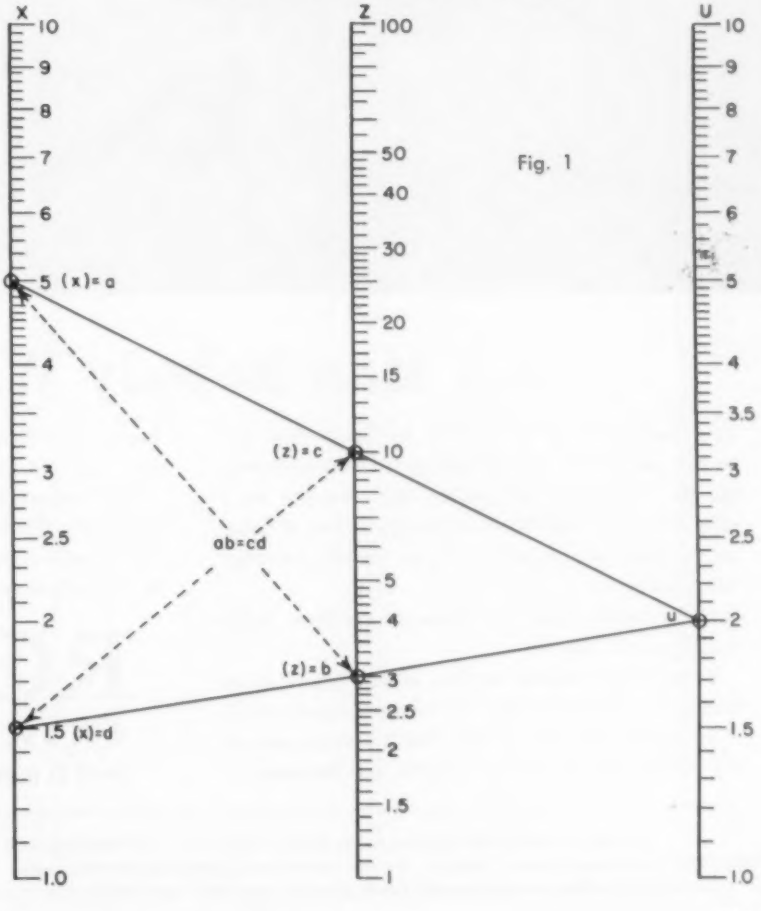

Fig. 1

A Man Nobody Wants

This man's motto is "Don't rock the boat!" Now that he has reached his present high post in the Company, his life is dedicated to proving that once you get a good thing, you don't have to change. In fact, if things get too new, you can always search the past for something really safe to use.

He, naturally, has no interest in the new things coming out of Rogers.

Rogers is not looking for him, either. Rogers serves engineers – those men who sail the seven seas in search of an eighth. And they, in turn, find Rogers an interesting port of call – a cove of research and development brains eager to meet the challenge of their ideas with new materials.

Our business is to create – if we don't already have them – the materials that engineers are seeking to convert today's dreams into actual products. Please write for samples of recent developments.

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SHOE MATERIALS—for Counters, Midsoles, Liners, etc. **PLASTICS**—Special Purpose Molding Compounds and Laminates **RUBBER**—for Floats, Grommets, Gaskets, Bearing Seals, etc.
FABRICATING—Including Converting, Combining, Coating, Embossing, and Molding **DEVELOPMENT**—Research and Engineering of Unique Materials, Parts and Products

Constructing Nomographs

(continued from p. 215)

them. Adequate blank copies of the graduated scales should be available for most freedom of use.

Example 1.

It is required to solve for the unknowns in

(9 Electra on 11 x 13)

$$\alpha r = 57.3\, hf$$

where

r = contact radius
f = cam factor depending upon pressure angle
h = rise of follower
α = phase angle

This is a formula used for determining the pitch circle radii of cams.

1. Reduce the five-quantity equation to four by letting $z = hf$, which gives

$$\alpha r = 57.3\, z$$

2. From 57.3 on X draw secant I cutting Z and U at points, α, and u.
3. From u draw secant II cutting Z and X at any points, z and r.
4. Through z on Z draw secant III cutting X and U at any points h and f respectively.
5. Read off the unknowns in accordance with

$$\alpha r = 57.3\, z$$
$$hf = z$$

Example 2.

The volume of a cylindrical tank is given by the four-quantity equation

$$1.28\, V = d^2 h$$

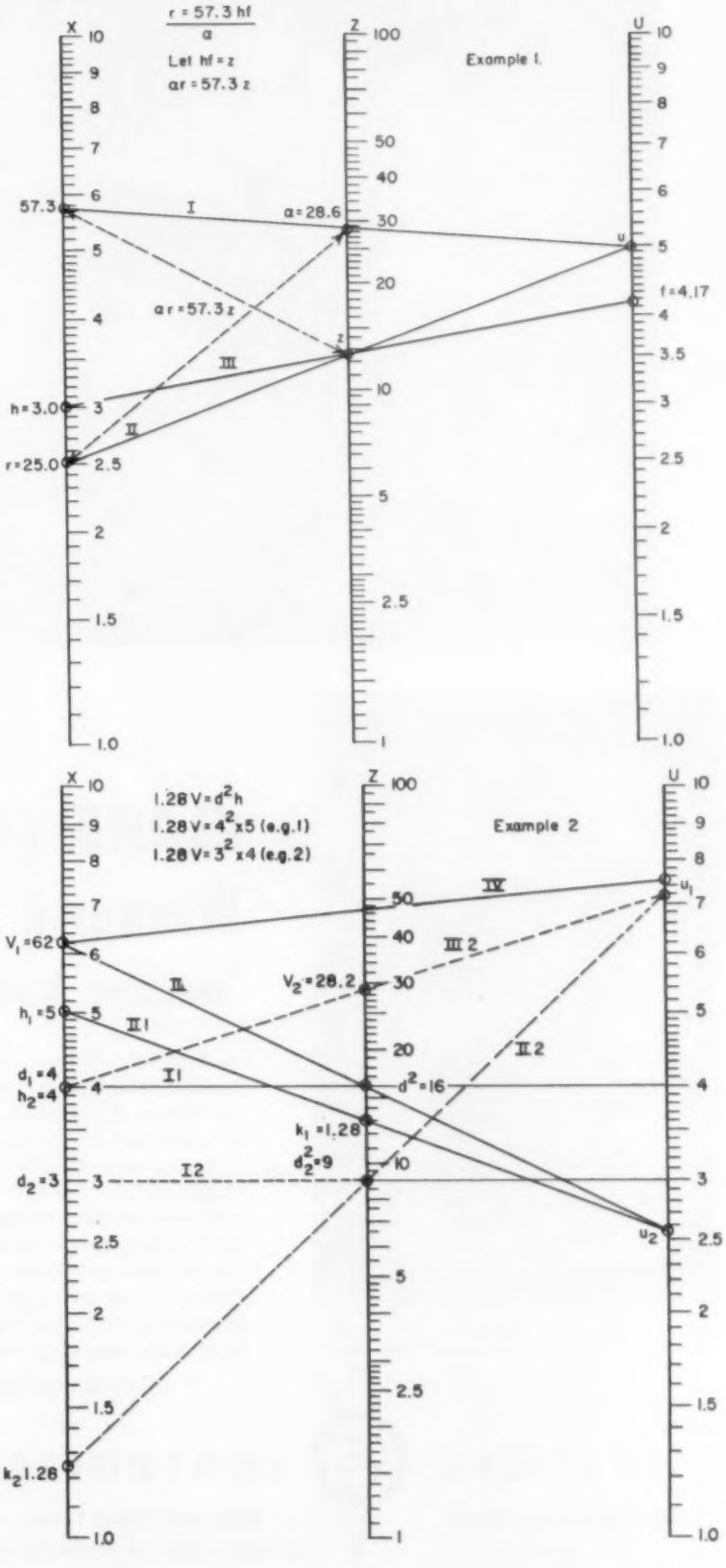
assuming

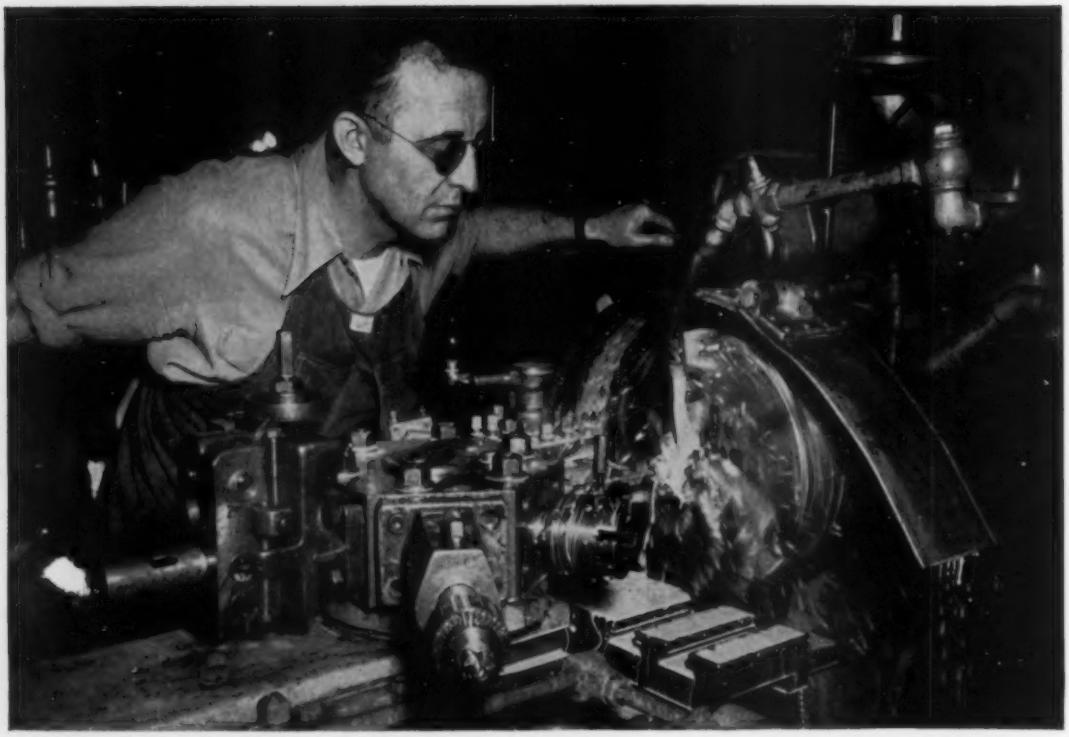
$d = 4$ ft., $h = 5$ ft (1)
$d = 3$ ft., $h = 4$ ft. (2)

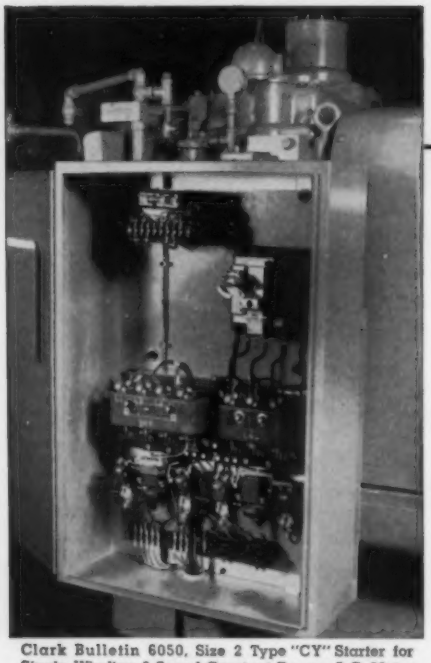
1. Draw secant I from 4 on X to 4 on U. This cuts Z at 16 = d^2. (Note: this secant need not actually be drawn so long as d^2 is found on Z.)
2. Construct the Vee composed of secants II and III such that 1.28 and V, 16 and h (= 5 in example 1) are diagonally opposed.
3. Read off values for V (= 62.5 cu. ft. in example 1, and 28.2 cu. ft. in example 2.)

If number of gallons that tank of volume V will hold is required, secant IV may be drawn from V on the X scale to 7.5 on U. Number will be read off on Z as 472 gallons as there are 7.5 gallons per cu. ft.

(continued on page 219)







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IN CANADA...CANADIAN CONTROLLERS, LIMITED • MAIN OFFICES AND PLANT, TORONTO

Construction Nomographs

(continued from page 217)

Example 3.

Weight W in lb. per foot of steel rod is given by

$$1.06\ W = Wd^2$$

using

$w = 0.283$ lb/cu. in., $d = 1.5$ in. dia.

This equation is similar to the one in example 2 except that the value of $d^2 = 2.25$ as found by secant I does not allow secant III to be drawn such that the other leg of the Vee, secant II, would be on the scales.

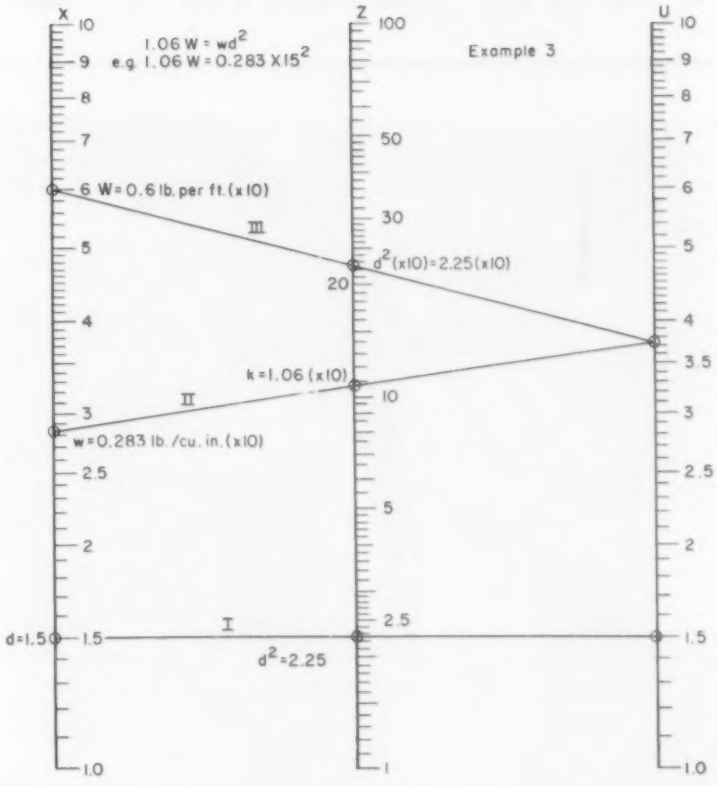
Secant I must therefore be moved up to III. All values thus read off will be 10 × their true value.

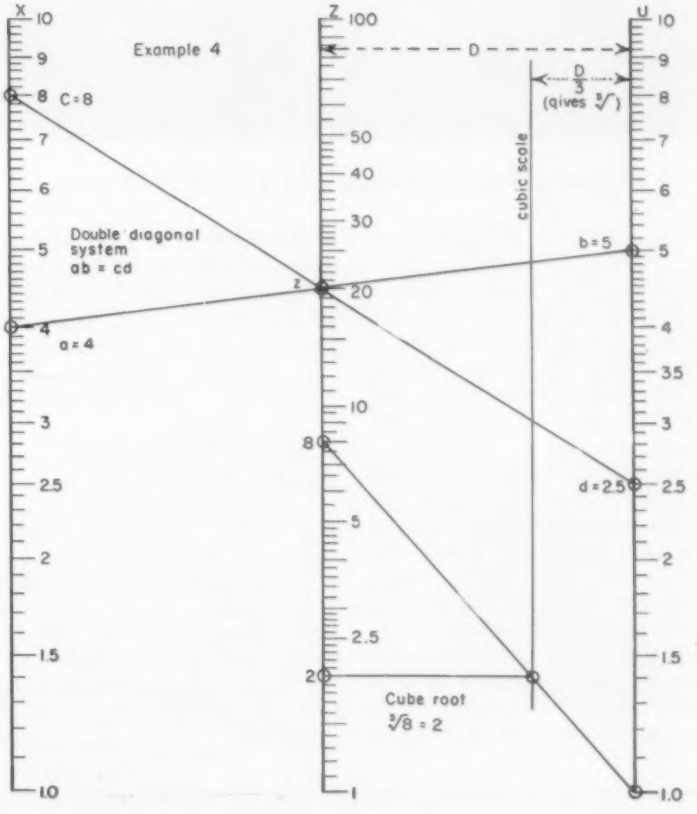
Example 4—Cube Roots.

An auxiliary cube scale is added to the standard nomograph form. If this pivot line is ⅓ distance from the *U* scale cube roots or cubes can be found on the Z scale as illustrated. Any root may be found on the Z scale by simply dividing the distance between the base '1' and the number by whatever root is required. Read off the answer opposite the dixision. Example: if the 5th root of 45 is required and the distance between 1 and 45 is 6 in., read off 2.15 (approx.) at a point 6/5 in. = 1.2 in. up from 1 on the Z scale.

Double-diagonal System.

Instead of the secants taking the form of a Vee they may intersect on Z. In this system one product appears on each end of a diagonal as shown. The double-diagonal system, however, is not convenient for squares as it involves transfers.





EDITOR'S NOTE—"Minimum Cam Size as Determined by Pressure Angle," July 1956 page 141, includes an alternative nomograph for solving the same formula as given in example 1 in this present article. "G Loading of Rotating Bodies," March 1956 page 219, uses the same type of nomograph as is described in the present article and is thus a further example of the variety of problems that can be solved with this basic nomograph form.

NEW COMPONENTS

Zippered Plastic Harness For Electrical Wiring

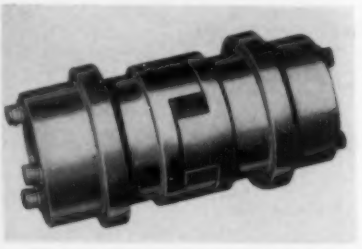
This device was designed to enclose, identify and protect multi-conductor wiring in aircraft, electronic or electrical installations. Additional potential applications are expected to include wiring ducts, wire marking (in short lengths), and as a replaceable cable jacket to protect cables from abrasive wear.

The zipper pull-tab used to close the tubing is detachable, and the tubing may be unzipped and re-used, or permanently sealed with a sealer provided by the manufacturer. When sealed, the tubing is said to withstand a linear strength-test of 30 psi. Available in nine colors, including black and clear plastic, this product is made of PVC compounds. Available sizes are from $\frac{1}{2}$ to $4\frac{1}{2}$ in. ID, in increments of $\frac{1}{8}$ in; wall thicknesses, 0.020 and 0.040 in. Available in continuous lengths from 20 to 1,000 ft. W. A. Plummer Mfg. Co., 752 S. San Pedro St., Los Angeles, Calif.

For more information—
Circle 1, inside back cover

Radially Removable Flexible Coupling

A flexible coupling provides a means of disconnecting two units without axial movement of the shafts. This coupling is for applications where driven equipment such as a pump must be disconnected while the driving unit continues to operate. Only the coupling has to be disassembled.



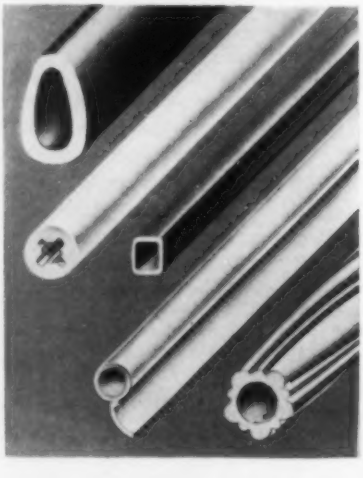
There is no wear on the metal jaws since the load is transmitted by compression of the one-piece load cushion. Ratings range from 7.5 to 40 hp at 1800 rpm. Maximum bores are from $1\frac{3}{8}$ to $2\frac{1}{4}$ in. with maximum OD, $2\frac{29}{32}$ to 5 in. Maximum overall length runs from $6\frac{1}{8}$ to $7\frac{3}{8}$ in. Lovejoy Flexible Coupling Co., 4856 W. Lake St., Chicago 44, Ill.

For more information—
Circle 2, inside back cover

Extruded Tubing with Internal, External Shapes

Tubes may be specified from 0.020 up to 3 in. ID, heavy or thin wall thicknesses. Hollow shapes are obtainable in cross-sectional designs such as oval, rectangular, flanged or keyed. Special surface effects such as ribs, beads or flutes and even spiralled beads can be designed into the inner or outer tube surface.

Extruded tubes and hollow shapes are obtainable in rigid, flexible, hard



or soft materials in both colors and crystal clear. They come cut to exact lengths or in coils, spools or random lengths. Anchor Plastics Co., Inc., 36-36 36 Street, Long Island City 6, N. Y.

For more information—
Circle 3, inside back cover

Adjustable Hole Gage

Accuracy and readability of the gage is said to be 0.0005 in. The scale is marked in increments of 0.001 in. and equipped with a 2.5X magnifying lens. A complete set of three gagés covers hole diameters from 0.025 to 0.380 in., each unit having a hole diameter range of 0.125 in.

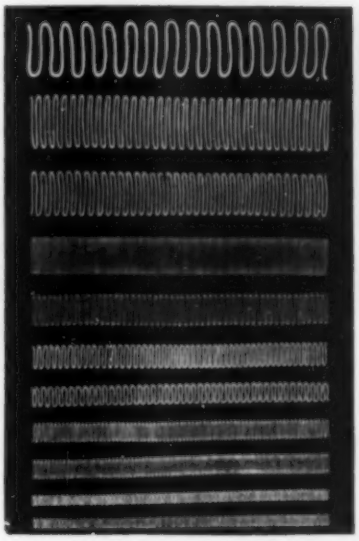
The gage is composed of three basic functional parts—a tapered retractable needle, a precision clutch mechanism and an easily-read magnified scale. Hole diameters are measured in four easy steps: 1) needle released by pushing the clutch button, 2) needle inserted in hole, 3) barrel pushed down flush with the piece being measured, and 4) gage removed and diameter read directly. Hamilton Watch Co., Allied Products Div., Lancaster, Pa.

For more information—
Circle 4, inside back cover

Flat Sinuated Heating Element Wire

This heat-producing medium is said to be particularly adaptable to electric heating problems where thin-wall, pliant construction is desirable. The flat sinuated element has maximum radiation surface exposure.

The wire is preformed to specification in width, length, turns per inch and type and gage of wire. It is available wound on spools or supplied in cut lengths. The flat sinuated width can be made from $\frac{1}{8}$ to 3 in. The width of sinuation is governed by the wire gage and the ability to handle it after it has been sinuated. Syntron Co., 240 Lexington Ave., Homer City, Pa.



For more information—
Circle 5, inside back cover

Divider for Hydraulic Flow

This flow divider can be adjusted with an ordinary screw driver to control flow over a range of 10 to 95 per cent. It also has a built-in relief valve that will pass the oil back to the sump when the peak pressure setting of the secondary flow is reached.

The divider is so designed that when the pressure of the primary operation begins to build up, the flow to the secondary operation begins to decrease. This means that on a fork truck for instance, no lifting power will be sacrificed to power steering.

The divider is said to permit two simultaneous operations from one pump. It operates on low circulation pressure from the pump and divides the flow in any desired proportion. It is unaffected by temperature and frees the system from the noise often characteristic of valves of this kind. New Products Corp., 3636 Oakton St., Skokie, Ill.

For more information—
Circle 6, inside back cover

High-Pressure Quick Disconnect

This unit can be used to disconnect safely a pressurized line, with pressures up to 3,000 psi, according to the maker. With the handle in the upright position as shown, an integral floating ball-seat valve is fully open. To disconnect the line, the handle is rotated 90 deg down. During this 90 deg movement, the valve closes and, simultaneously, the pressure downstream from the valve seal is automatically bled out.

The fitting at the downstream end cannot be removed while the valve is in the open position. Nor can the valve be put into the open position with the downstream fitting disengaged. Ambient and operating temperatures from −65 F to 200 F. Line

CONTINUED ON PAGE 222

sizes currently available include ¼, ⅜ and ½ in. Weight of ¼ in. model is 0.37 lb. Hydromatics, Inc., Cedar Grove, N. J.

For more information—
Circle 7, inside back cover

Plug-In Control

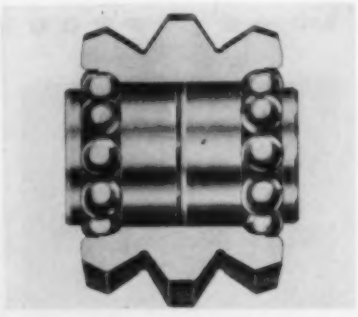
A plug-in static control unit has been designed to handle protective functions such as undervoltage protection, undervoltage release, switch volts protection, overvoltage limit, fault indication, and others. The unit provides protective functions by means of three electrically-isolated control windings, one of which is suitable for use in circuits up to 750 v d-c, on a magnetic amplifier unit. The encapsulated, plug-in unit is equipped with a monitor light which indicates at a glance whether or not the unit is in operation. General Electric Co., Schenectady 5, N. Y.

For more information—
Circle 8, inside back cover

MECHANICAL COMPONENTS

Toothed Roller Bearing

These bearings are designed for use in such mechanisms as the manual steering mechanism of automobiles, trucks and tractors. The profile of the bearing outer ring permits it to



engage a worm gear on the steering shaft. Marlin-Rockwell Corp., Jamestown, N. Y.

For more information—
Circle 9, inside back cover

Self-Sealing, Vibration-Resistant Screws

These are standard machine screws with an O-ring which is pressed into a groove under the fastener head. When used on a panel, housing, or cabinet, tightening the screw compresses the ring to achieve vibration resistance and high-pressure sealing. A range of standard and special sizes and threads is available. Automatic & Precision Mfg. Co., 252 Hawthorne Ave., Yonkers, N. Y.

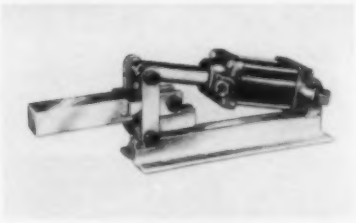
For more information—
Circle 10, inside back cover

Carbon-Faced, Self-Contained Seal

This seal can be used on any rotating shaft to seal any liquids that will not attack its Buna-N or brass parts. The face of the seal, capable of withstanding high face loading and heat, is manufactured from filled true carbon to prevent porosity. A roll-designed bellows has been incorporated into the seal. The brass shell is a rigid two-piece design in which the shell is rolled over an offset washer at the back. This imparts greater stability and strength over the one-piece stamped shell.

The seal is made to operate against pressures up to 100 psi, and is available for ⅝ and ¾ in. dia shafts with general operating limitation of 212 F, with shaft speeds up to 1,000 fpm. Garlock Packing Co., 400 Main St., Elmira, N. Y.

For more information—
Circle 11, inside back cover



Heavy Duty Clamps

The heavy-duty hand clamp is available in four models with either a solid bar or channel bar of cold rolled steel, with clamping pressures of either 200 or 400 lb. In the heavy-duty air or oil-operated clamps, air can be supplied from right or left by rotating clamp cylinder. In addition, failure of air or oil pressure will not release the clamp. Lapeer Mfg. Co., 3042 Davison Road, Lapeer, Mich.

For more information—
Circle 12, inside back cover

Miniature Gear Boxes

A series of gear boxes for electronic and instrument applications, servomechanisms, computers, small actuators and electronic components is available in a wide range of gear ratios, from 4:1 to 12,000:1. The Size 11 gear box provides torque up to 45 in-oz. Sizes 15 and 18 provide torque up to 65 and 100 in-oz, respectively.

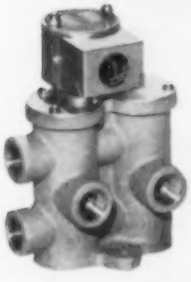
Precision ball bearings are used

CONTINUED ON PAGE 224

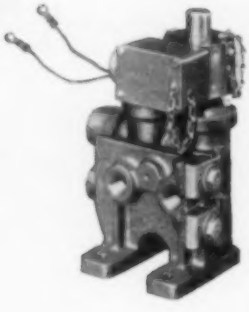
Crescent® Solenoid Valves

COMPETE ON PRICE

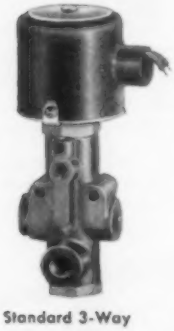
BUT LEAD IN SERVICE LIFE



Standard 4-Way



J.I.C. Type 4-Way



Standard 3-Way

® 4-Way and 3-Way Solenoid operated, pilot controlled valves for Air, Water and light oil to 150 P.S.I., products of Crescent Valve Co.

NO COIL BURNOUT

because a generous power margin, short solenoid travel and pilot operation combine to prevent overheating and overloading. Note that these valves are accepted and used in automotive plants where assembly line production does not permit coil or valve failure.

LONG SERVICE LIFE

Main valve design is aimed at extremely long trouble free service. Resilient seats are tight sealing and are not affected or damaged by dirt or grit because they are of a self scavenging design. Witness their superior performance in such severe service as operating hopper doors on cement batching equipment and in other dusty environment.

INTERCHANGEABILITY

Solenoids and pilot sections are interchangeable from one valve size to another, minimizing spare parts requirements. Adaptation to any practical voltage is achieved by a simple coil change.

Speed of response, speed of installation and dependable leakproof operation year in and year out are responsible for the increasing switch to Crescent valves on production machinery where time is money.

For complete data write for Catalog 6-C.

BARKSDALE VALVES

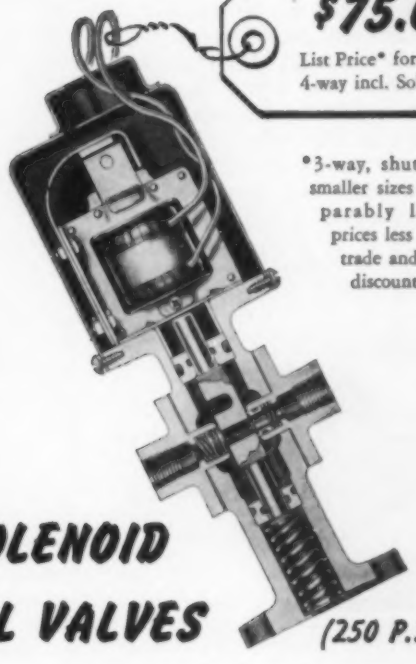
5125 Alcoa Avenue, Los Angeles 58, California

LEAKPROOF (SHEAR-SEAL)

$75.00

List Price* for a ½" 4-way incl. Solenoid

*3-way, shut-off and smaller sizes are comparably less. All prices less the usual trade and quantity discounts.



SOLENOID OIL VALVES (250 P.S.I.)

WHERE	WHY	HOW
Thread rolling machines	Holding position (leakproof)	Lapped sealing surfaces seal tight indefinitely as a result of wear compensation
Pressure testing in automotive production	Oil gets contaminated by scale in castings (not critical to dirt) reduced maintenance	Sealing surfaces in constant, intimate contact, dirt can't lock valving members—saves coil burn-out
Hydraulic work feed apparatus	(Leakproof) ... as versus spool valves which cause overdemand on hydraulic system	Positive shut off of internal port to port leakage and of course, no external leakage
Machine tool chucking & clamping	Maintaining safe holding pressure (leakproof)	Saving auxiliary equipment such as pilot operated check valves
Automatic door openers	Quick action (high flow capacity)	No spools or poppets obstructing full, round flow passages
Solenoid controlled hydraulic system on machine you build	Better performance	Shear-Seal valves have full flow, are leakproof, not sensitive to dirt
	Lower manufacturing costs	Low priced, less auxiliary equipment and labor cost.
	Reduce service problems	Valves don't stick, saving coil burn-out; stay leakproof indefinitely, seals are wear compensating

BARKSDALE VALVES

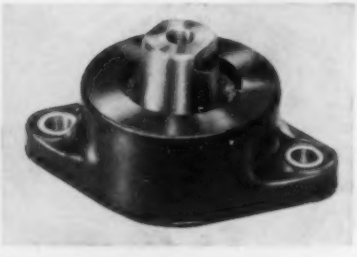
5125 Alcoa Avenue, Los Angeles 58, California

Ask for bulletin 5S-H

throughout, with sealed, permanently lubricated bearings used on the output stage. The gear boxes are designed so they can be mounted directly on small electric motors.

Size 11 is 1.062 × 1.55 in. long, and weighs 2 to 4.5 oz. Size 15 is 1.437 × 1.82 in. long, and weighs 2½ to 5 oz. Sizes 18 is 1.750 × 1.90 in. long, and weighs 2½ to 5 oz. Southwestern Industries Inc., 5880 Centinola Ave., Los Angeles, Calif.

For more information—
Circle 13, inside back cover



All-Metal Vibration Mounting

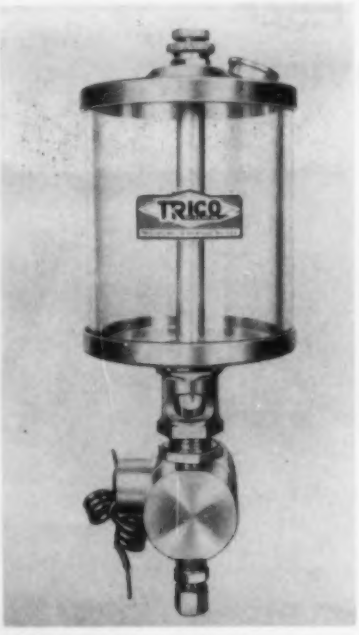
Originally for shipboard electronic equipment, natural frequency is 5 to 12 cps. This is said to provide isolation from high-impact shocks of local explosions, gunfire, and steady state vibration due to engine and propeller vibration. Isolation of vibration is 80 per cent at 40 cps and improves at higher frequencies.

Within the mounting, a knitted stainless steel cushion, enclosed within a helical spring, provides a non-linear spring rate which increases support under overload conditions. The mount is available in three load ranges: 20 to 30 lb, 30 to 40 lb, 40 to 50 lb. Robinson Aviation, Inc., Teterboro, N. J.

For more information—
Circle 14, inside back cover

Gravity Feed Oilers

A special reservoir built into the oiler automatically floods bearing with a fixed amount (about ⅛ oz) of lubricant when the oiler valve is opened. Following the flushing cycle, oiler functions in normal manner,



feeding lubricant drop by drop at any required rate, and again stores up oil for the next flushing cycle while machine is idle. Oil flushing after shutdown periods is especially desirable with vertical shafts, where oil drain-off is especially pronounced, and with high speed spindles where full lubrication is required the instant the machine is started.

Oilers are available in 10 oz, 1 pint, 1 quart and 2½ quart capacities, with either heat-resisting Pyrex or shatterproof Lucite reservoirs and with manual or electrical solenoid shut-off valves. Trico Fuse Mfg. Co., 2948 N 5 St., Milwaukee 12, Wis.

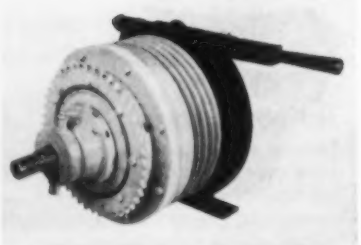
For more information—
Circle 15, inside back cover

Ball Joint for Over 250 Lb

Ball socket is in the same unit as the cross-drilled hole, adding wall thickness. Swivel is assembled with a grease-resistant neoprene washer, to cushion movement and maintain proper tension. A spring clip allows rapid adjustment over great length, eliminating threaded rods and conventional set screws. Nut, lockwasher and spring clip are permanently assembled on the unit to prevent loss. Present usage includes automatic

transmission, heating, ventilating and air control applications. J. J. Tourek Mfg. Co., 1901 S. Kilbourn Ave., Chicago 23, Ill.

For more information—
Circle 16, inside back cover



Two-Speed Reduction Pulley

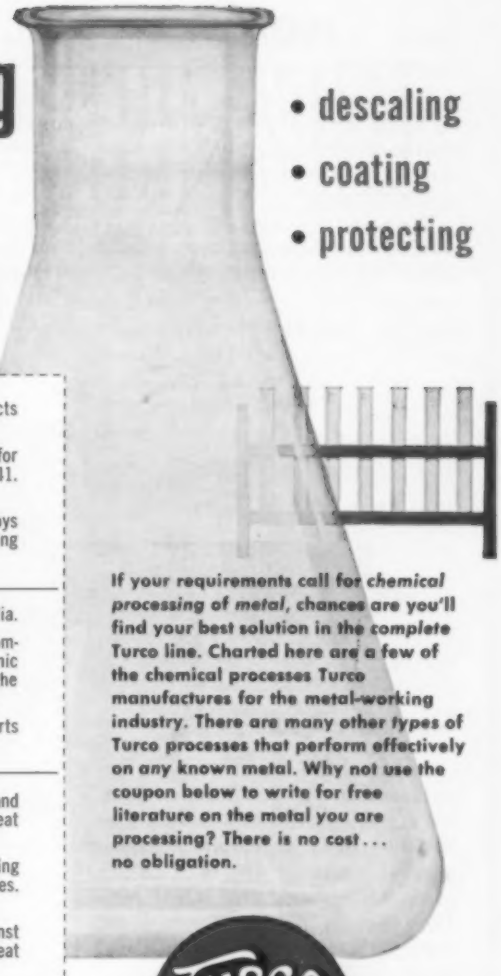
This pulley is equipped with internal planetary gearing to provide speed reductions up to 8000:1. It is available for two-speed operation and may be supplied for V-belt drive or adapted for chain or gear drive.

Two clutches are provided. A standard disc clutch locks the housing direct to the shaft and gives normal V-belt reduction, while a drum-type clutch, built into the pulley and operating through the internal gearing, permits much larger reductions. By the use of two built-in, drum-type clutches, two internally reduced speeds may be obtained. These two speeds may be in the same direction, or one forward and one reverse.

Instead of disc or drum-type clutches as shown, the unit may be

CONTINUED ON PAGE 226

FOR chemical processing OF ANY METAL... turn to Turco...FIRST!



- descaling
- coating
- protecting

ALUMINUM	**DESCALING:** Complete line of deoxidizing and polishing products for all alloys of aluminum. **COATING:** Economical and "quick fixing" conversion coating for application by spray, dip or hand methods. Approved to MIL-C-5541. Insures paint adhesion, stops aluminum corrosion. **PROTECTION:** Alkali-removable protective film for aluminum alloys both during storage (in plant and outdoor) and during fabricating practices.
STEEL	**DESCALING:** Complete line of alkaline and acid descaling media. **COATING:** Full line of iron, zinc and manganese phosphate compounds to provide a tight coating for better adhesion of organic finishes and for oil absorption. These materials all meet the various requirements of applicable government specifications. **PROTECTION:** Versatile group of products for protection of parts from the elements.
TITANIUM	**DESCALING:** Approved and accepted process for conditioning and removing scale from all current titanium alloys, both after heat forming to 1150° F. and heat treating to 1750° F. **COATING:** Acceptable anti-galling and seizing conversion coating for the major alloys of titanium. Also used as base for lubes. Requires no post-heat treatments. **PROTECTION:** Easily removable coating to protect titanium against tightly adhering scale up to 1600° F. during hot forming or heat treating.
STAINLESS STEEL	**DESCALING:** Process for completely removing heat scale from various alloys (including 17-7 PH). **COATING:** Easily removable coating to protect stainless steel against tightly adhering scale up to 1600° F. during hot forming or heat treating.
MAGNESIUM	**DESCALING:** Non-electrolytic alkaline process for removing previous chrome pickle films as well as oily substances often found on magnesium. **COATING:** One-package powdered product which, when in solution with water, replaces Dow #17 treatment. Requires no mixing of chemicals. Eliminates chance of human error. **PROTECTION:** Single-package touch-up liquid to produce coatings equal to Dow #18 treatment. (Note: All magnesium processes mentioned above are approved for use by Magnesium Department, Dow Chemical Co.)

If your requirements call for *chemical processing of metal*, chances are you'll find your best solution in the *complete* Turco line. Charted here are a few of the chemical processes Turco manufactures for the metal-working industry. There are many other types of Turco processes that perform effectively on any known metal. Why not use the coupon below to write for free literature on the metal you are processing? There is no cost... no obligation.

TURCO

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Chemical Processing Compounds
6135 So. Central Ave., Los Angeles 1, California
Factories: Newark, Chicago, Houston, Los Angeles, London, Rotterdam, Sydney, Mexico City, Naha (Okinawa)
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For Cleaning or Metal Conditioning Problems— Turn to Turco ...First!

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Please send free literature on chemical processing of the metals checked

Titanium____ Stainless Steel____ Magnesium____

Steel____ Aluminum____ Other (specify)____

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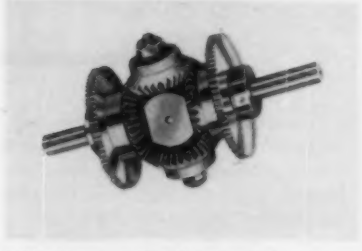
TITLE____

PE

equipped with almost any type of electrical, mechanical or pneumatic clutch. Clutches may be remotely controlled if desired.

The pulleys can operate either horizontally or vertically, are entirely sealed, equipped with hardened gears running in oil. Overload release is available. Hart Reduction Pulley Co., 426 W. Main St., Waukesha, Wis.

For more information—
Circle 17, inside back cover



Miniature Differentials

Three models are in stock for immediate delivery. BP-301, the largest, has a ¼ in. shaft, a breakaway torque of 0.065 in-oz, a maximum recommended torque of 150 in-oz, and a maximum recommended 1,800 rpm. The smallest, BP-320, has a ⅛ in. shaft, a breakaway torque of 0.060 in-oz, a maximum recommended torque of 90 in-oz and a maximum recommended 1,400 rpm. Helipot Corp., Newport Beach, Calif.

For more information—
Circle 18, inside back cover

Self-Locking Anchor Nut

The nut's elliptical locking device assures self-locking action under even severe vibration. Repeated insertions and removals of mating screws are possible without loss of locking ability. The nuts which are harder than most mating screws cannot be damaged by cross-threading. Carbon steel nuts are approved for use in temperatures up to 550 F. For higher temperature or non-magnetic applications, nuts of A286 steel are manufactured. Available in a complete range of sizes from 8-32 through ⅜-24. Kaynar Co., Box 2001, Terminal Annex, Los Angeles 54, Calif.

For more information—
Circle 19, inside back cover

Reinforced Plastic Wheel

These wheels are regularly furnished in 3 through 12 in. dia, with alloy steel roller bearings and provision for pressure lubrication. Fairbanks Co., 393 Lafayette St., New York, N. Y.

For more information—
Circle 20, inside back cover

Reversing Clutch

In this torque converter transmission there is no clutch or gear shifting. A single throttle lever changes both direction and speed of travel. Two foot pedals may be substituted for the lever. Movement from the neutral, or center, position engages the hydraulically operated clutch, and further movement—forward or reverse—controls speed.

The drive is adaptable to any operation involving change in direction of movement, either forward and reverse, or lift and lower, on equipment with engines up to 250 cu in. displacement. Funk Aircraft Co., Box 577-CQ, Coffeyville, Kan.

For more information—
Circle 21, inside back cover

Miniature Slip Clutches

Basically, there are three types of clutches in this line: magnetic, spring beam, and a multiple disc friction. These units maintain a given toque output for indefinite periods of time.

They also operate at any rpm and maintain the required torque.

These torque-limiting devices are constructed in five sizes from ¾ to 2¼ in. OD with bore sizes of ⅛ to ½ in. and capacities from 1 in-oz to 800 in-lb. Radial Metal Products, Inc., 1044 Linwood St., Brooklyn 8, N. Y.

For more information—
Circle 22, inside back cover

Heavy-Duty Caster

This caster is for loads up to 5 tons per caster. Faultless Caster Corp., Evansville, Ind.

For more information—
Circle 23, inside back cover

All-Metal Mounting

Available in load ranges from 50 to a 1000 lb per unit, the series is adaptable to industrial, vehicular and railroad applications. The non-linear spring rate produces increasing stiffness as loads increase, preventing

CONTINUED ON PAGE 228

NEW

KAYDON THIN SHELL NEEDLE BEARINGS

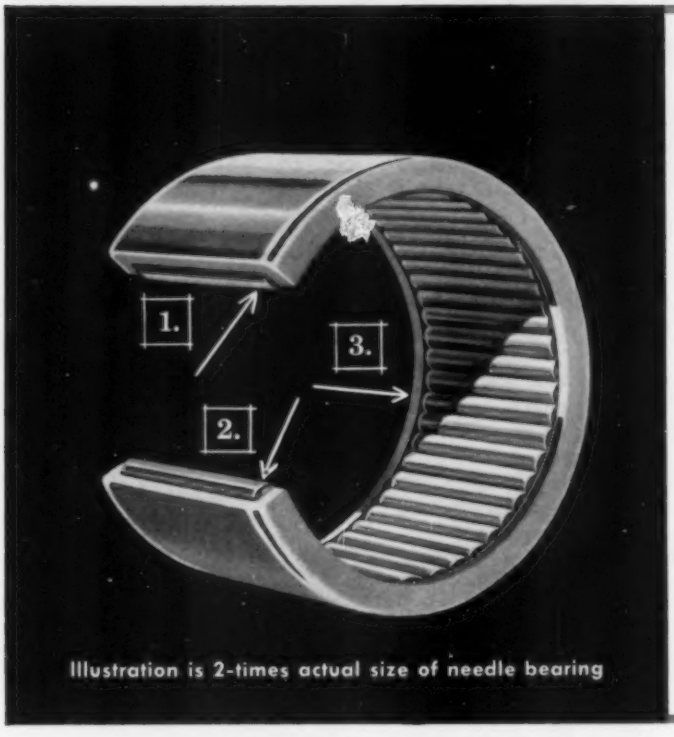
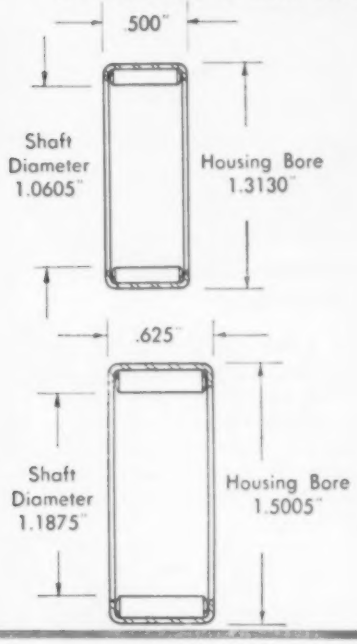


Illustration is 2-times actual size of needle bearing

Two standard sizes available from stock



You get these Kaydon design advantages:

1. Greater effective length needle rollers for MORE CAPACITY (41% on ½" width) . . . LONGER LIFE (2.8 times as much on ½" width) 2. Simplified construction that SAVES you money 3. Pre-packed lubrication that SAVES assembly time.

These new thin-shell bearings were developed with the co-operation of the FORD MOTOR COMPANY for use in FORD-O-MATIC and MERC-O-MATIC automatic transmissions

Kaydon's new thin-shell needle bearing gives more of everything — *more economy . . . more capacity . . . plus longer life* than any other comparable bearing. That's because of Kaydon's greater effective length of spherical end rollers.

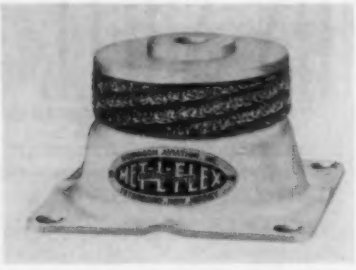
This new bearing is ready for you right now from stock in two standard sizes (illustrated). Other sizes will be available later.

For complete specifications, ask for Data Sheet No. K562 — write, call or wire Kaydon of Muskegon.

THE KAYDON ENGINEERING CORP.

MUSKEGON • MICHIGAN

All types of ball and roller bearings — 4" inside diameter to 124" outside diameter . . . Taper Roller • Roller Thrust • Roller Radial • Bi-Angular Roller • Spherical Roller • Needle Roller • Ball Radial • Ball Thrust Bearings



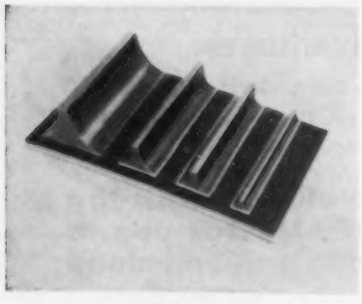
abrupt "bottoming" of the mounting. Severe rebounds due to shock are eliminated through inherent damping of the resilient element. Robinson Aviation Inc., Teterboro, N. J.

For more information—
Circle 24, inside back cover

Molybdenum Disulfide-Filled Nylon Washers

These nylon thrust washers are available from stock in a range of sizes. They are stamped from strip to outside diameters $\frac{3}{8}$ to $1\frac{7}{16}$ in. and $\frac{1}{8}$ to 1 in. ID. They are available in thicknesses of $\frac{1}{64}$, $\frac{3}{32}$ and $\frac{1}{16}$ in. Polymer Corp., of Pennsylvania, Reading, Pa.

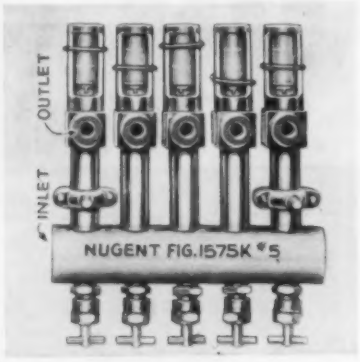
For more information—
Circle 25, inside back cover



Cleats for Inclined Conveyor Belts

These cleats can be applied to the belt at 90 deg (across the belt) in the form of chevrons, or along the sides of the belt to act as guide rails. Cleats are available in four heights: $\frac{7}{16}$, $\frac{3}{4}$, 1 and $1\frac{1}{2}$ in., all in 36 in. lengths. Flexible Steel Lacing Co., 4607 Lexington St., Chicago 44, Ill.

For more information—
Circle 26, inside back cover



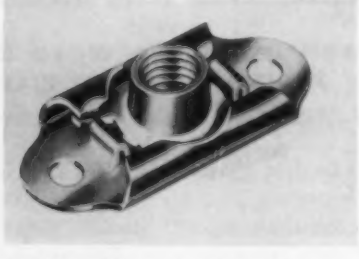
Pressure Sight Flow Lubricator

This unit will deliver lubricating oil or other liquids under pressure, in accurately measured quantities, to high or otherwise inaccessible points. They are available as single units, or in multiples up to 15 depending upon the number of feeds required.

Each lubricator making up a multiple unit is capable of feeding fluid in amounts varying from several drops to 2 pints per min by simple adjustment of the individual needle valves.

Single lubricators are available with $\frac{1}{4}$ or $\frac{3}{8}$ in. inlet and outlet. Inlet sizes of multiple units range to $\frac{3}{4}$ in. with $\frac{1}{4}$ or $\frac{3}{8}$ in. outlets. All are designed for 125 psi maximum working pressure. Wm. W. Nugent & Co., Inc., 3440 Cleveland St., Skokie, Illinois.

For more information—
Circle 27, inside back cover



Self-Locking Anchor Nuts

This line of fixed and floating self-locking anchor nuts and gang channel is now available with thread-relief in a range of sizes from 8-32 through $\frac{3}{8}$-24. The thread-relief design, by allowing the bolt grip to enter the base of the nut, reduces the need for shims and changes in bolt-grip lengths. By eliminating threads in bearing, it also helps to insure a structurally sound joint. These nuts are approved for use in temperatures up to 550 F. Other materials are available for higher temperatures. Kaynar Co., Box 2001, Terminal Annex, Los Angeles 54, Calif.

For more information—
Circle 28, inside back cover

Fasteners for Unthreaded Studs

Fasteners for unthreaded studs of die-cast nameplates, medallions, grilles and ornaments are now available made of Type 410 stainless steel. Sizes are available for $\frac{1}{8}$, $\frac{5}{32}$ and $\frac{3}{16}$ in. studs. Palnut Co., Glen Road, Mountainside, N. J.

For more information—
Circle 29, inside back cover

Gearmotor

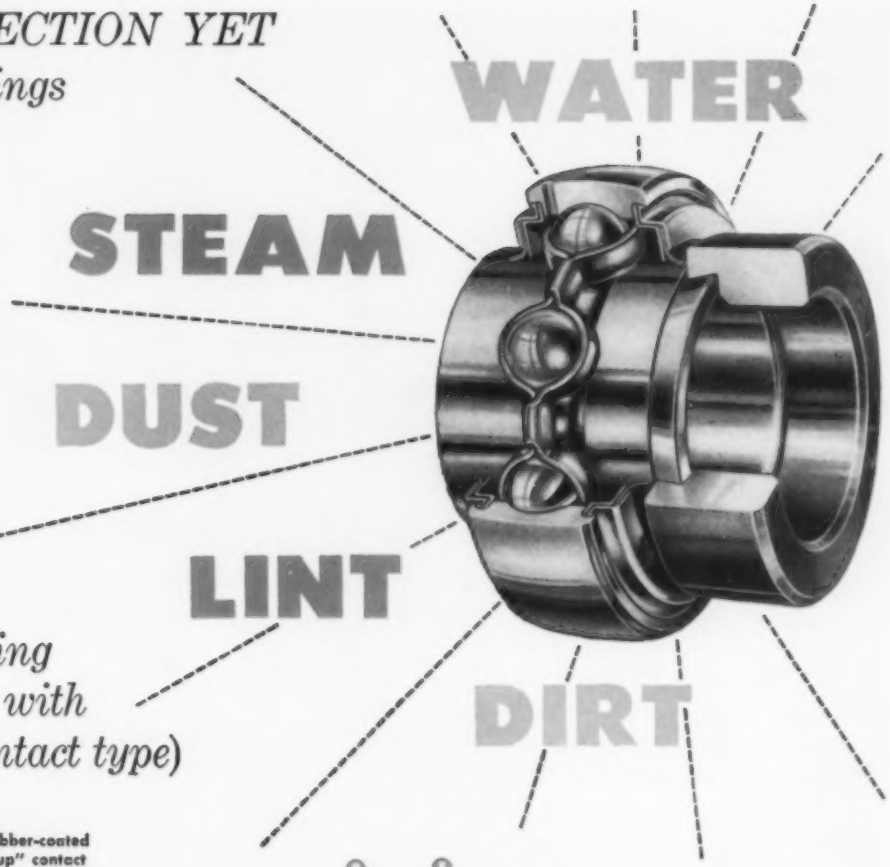
Cartridge assembly and electric motor can be removed from the gear-case without touching the base of the unit. All integral sizes have totally enclosed, fan-cooled motors, NEMA standard D flange, at no extra cost.

These motors are now available from stock in all speeds from $\frac{1}{2}$ to 15 hp. Rockwood Pulley Mfg. Co., 20 Crosby St., New York 13, N. Y.

For more information—
Circle 30, inside back cover

CONTINUED ON PAGE 230

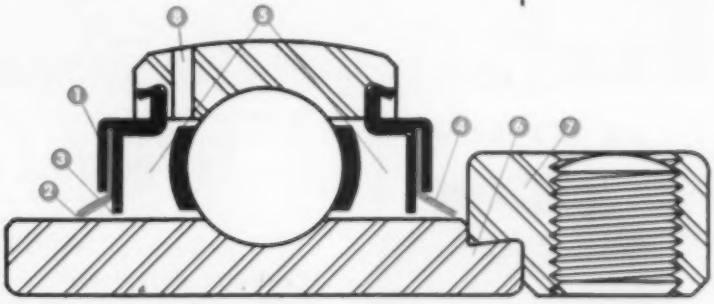
BEST PROTECTION YET
for Ball Bearings
exposed to



FAFNIR
Wide Inner Ring
Ball Bearings with
Plya-Seals (contact type)

FEATURES

1. **Plya-Seal of resilient Buna N rubber-coated fabric insuring proper "follow-up" contact**
2. **Seal rides in firm contact on ground outside diameter of inner ring**
3. **Close-clearance of inside metal shield with outside diameter of inner ring provides rigid support for seal**
4. **Flared lip of Plya-Seal won't push in**
5. **Generous space for lubricant**
6. **Wide inner ring for extra shaft support**
7. **Fafnir-originated self-locking, eccentric-cam-design collar**
8. **Relubricatable**



On slow to moderate speed applications where service conditions are subject to excessive contamination, Fafnir Plya-Seal equipped Wide Inner Ring Ball Bearings fill a definite need. Their laboratory and field-tested performance offers the proven protection of contact-type Plya-Seals. They provide every advantage of Fafnir Wide Inner Ring Ball Bearings with Self-Locking Collars . . . ease of application, positive locking, extra large support area on the shaft, relubricatable or nonrelubricatable, self-alignments.

The Plya-Seal as incorporated in the Fafnir Wide Inner Ring Bearing consists of two steel plates between which is sandwiched a synthetic rubber-coated fabric sealing washer. Both steel plates are fixed securely in an outer ring groove. The inner plate provides a rigid backing for the seal and a close-clearance baffle for the retention of grease.

This recent addition to the Fafnir Line is dimensionally interchangeable with the Fafnir Wide Inner Ring Ball Bearings equipped with Mechani-Seals. All types are prelubricated at the factory. Write for descriptive bulletin. The Fafnir Bearing Company, New Britain, Connecticut.

FAFNIR WIDE INNER RING BALL BEARING WITH PLYA-SEALS AVAILABLE IN UNITS BELOW

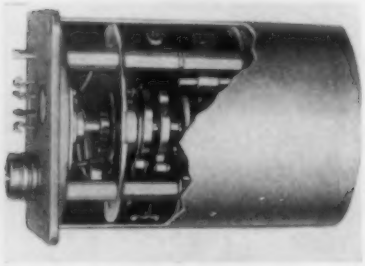
RAK

RCJ

Flangette

FAFNIR
BALL BEARINGS
MOST COMPLETE LINE IN AMERICA

ELECTRICAL POWER, CONTROL



Hermetically Sealed Timing Device

A time delay relay measuring approximately 2⅜ x 2⅜ x 3⅞ in. and weighing 30 oz or less is available with from one to six contacts. Time cycles range from fractions of seconds to multiple hours. Timer shown has provision for external timing adjustment.

A synchronous timing motor is used for 60 and 400 cps applications. For d-c applications, either a permanent magnet-type motor or a governor-controlled motor may be used, depending on accuracy requirements. Eagle Signal Corp., Moline, Ill.

For more information—
Circle 31, inside back cover

Electronic Read-out Tube

This device converts electronic signals directly to readable characters. It contains all numerical digits, any one of which can be selected and displayed in a common viewing area. It can be triggered by beam switching tubes or any suitable voltage source, requiring approximately ¼ w. Applications for the tube include computer read-out, industrial control, electronic instrumentation, military electronic control, and channel selectors. Burroughs Corp., Plainfield, N. J.

For more information—
Circle 32, inside back cover

Instrument Translator

A transistor-equipped instrument translator permits substitution of variable reluctance electro-mechanical pickoffs for potentiometers in aircraft and missile systems without adding appreciably to size and weight. The translator receives power from the system power source, whether a-c or d-c, and when connected with a suitable a-c sensing transducer it produces a d-c or a-c signal which is proportional to the physical changes sensed by the transducer. Crescent Engineering & Research Co., 5440 N. Peck Road, El Monte, Calif.

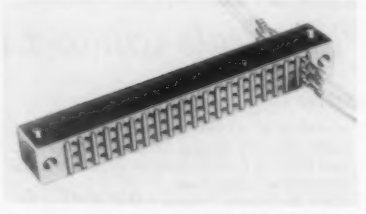
For more information—
Circle 33, inside back cover

Constant Reference Voltage Supply

This voltage supply converts a-c into a highly stable d-c reference voltage. Although designed primarily as a reference voltage for adjustable-speed motor drives and d-c servo systems, it may be used in some applications to replace standard cells, wet or dry cells, and more extensive electronic regulating systems.

When connected to a 115-v supply (50 to 400 cps), the unit will supply a reference potential adjustable from 0 to approximately 87 v and will maintain the desired voltage with a stability of better than 0.2 v, 0.2 per cent. This reference voltage is maintained with any load not exceeding 1 milliamp and throughout a temperature range of −50 C to 40 C, and with line voltage changes from 90 to 135 v. Servo-Tek Products Co., 1086 Goffle Road, Hawthorne, N. J.

For more information—
Circle 34, inside back cover



Taper Pin Terminal Blocks

Positive locking is secured between the taper pin and molded-in machined tapered receptacle. The blocks are fabricated in a single row of 20 contacts, in 10 dual contacts and in 10 single contacts. DeJUR-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y.

For more information—
Circle 35, inside back cover

Switch Actuated By Solenoid

This is a electromagnetic switch actuated by a solenoid plunger. It combines the characteristics of both a relay and a solenoid. Designed primarily for heavy duty motor and heater loads, unit has been tested for 230 v a-c, motor loads up to 3 hp and for heater units up to 8400 w.

Available contact combinations: single-pole, single-throw, dual make; single-pole, single-throw, dual break;

CONTINUED ON PAGE 232

Are your Oil Seals burning up?

Oil seal failure often results from excessive heat . . . caused by friction plus high operating temperatures. New hi-temperature applications for both lubricating and Type-A transmission oils are putting the heat on seal manufacturers.

That's why IPC has custom compounded new BUNA-N seal materials especially for hi-temperature use. In many instances, IPC's BUNA-N Oil Seals are ideal for operating temperatures up to 325° F.

Naturally your specific application is the deciding factor. If you're interested in lower-cost oil seals for temperatures up to 325° F. be sure to check your specifications with IPC . . . the foremost custom compounders of packings — oil seals — precision molding.

BONDED BY IPC

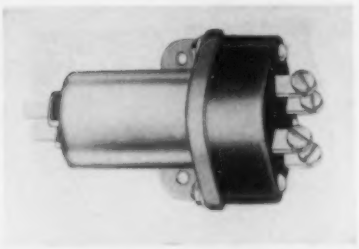
1. Bonded Washer Seal Double Lip Wiper
9. Bonded Case Seal Straight Lip With Garter Spring
2. Bonded Case Seal Double Lip Wiper
10. Bonded Case Seal Limited Contact Lip With Garter Spring
3. Bonded Washer Seal Straight Lip
11. Bonded Case Seal Straight Lip Thin Rind Type
4. Bonded Washer Seal Limited Contact Lip
12. Bonded Case Seal Limited Contact Lip Thin Rind Type
5. Bonded Washer Seal Straight Lip With Garter Spring
13. Rubber Covered Bonded Case Seal Straight Lip
6. Bonded Washer Seal Limited Contact Lip With Garter Spring
14. Rubber Covered Bonded Case Seal Limited Contact Lip
7. Bonded Case Seal Straight Lip
15. Rubber Covered Bonded Case Seal Straight Lip With Garter Spring
8. Bonded Case Seal Limited Contact Lip
16. Rubber Covered Bonded Case Seal Limited Contact Lip With Garter Spring

INTERNATIONAL PACKINGS CORPORATION

Bristol, New Hampshire

PACKINGS · OIL SEALS · PRECISION MOLDING

P2



or with single-pole, double-throw, dual make and dual break; also with single-pole, single-throw, dual make, or single-pole, single-throw, dual break, using an auxiliary switch on outside of housing.

Assigned contact ratings: 3 hp UL-motor load at 230 v, 60 cps, 6000 w resistive load; 500 w tungsten lamp load. Coils are standard voltages up to 230 v a-c, 60 cps and up to 110 v d-c. Guardian Electric Mfg. Co., 1621 W. Walnut St., Chicago 12, Ill.

For more information—
Circle 36, inside back cover

Plug-In Relay

This relay comes in contact arrangements up to double-pole, double-throw. Silver contacts are rated at 10 amp, 115 v a-c, non-inductive. Coils in all standard a-c and d-c voltages. Dimensions: $3\frac{1}{4}$ x $1\frac{7}{8}$ x 2 in. Line Electric Co., 1407 McCarter Highway, Newark 4, N. J.

For more information—
Circle 37, inside back cover

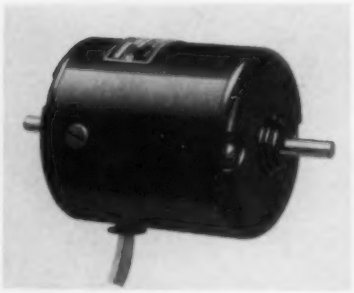
Miniature Trimming-Type Potentiometers

The potentiometer has a resistance range of 500 to 20,000 ohm in standard models, and is capable of functioning efficiently at ambient temperatures up to 200 c. A stainless steel adjusting shaft rides on cast metal bearings metallically bonded to the ceramic frame to assure proper alignment and to prevent backlash. The contact carrier is a heat-resistant Teflon block, and the contact is a precious metal multi-finger spring.

Two standard models are available: Model 50, which weighs approximately 0.25 oz and measures $\frac{3}{8}$ x $\frac{3}{8}$ x $1\frac{1}{4}$ in.; and Model 52, an encapsulated version $\frac{1}{4}$ in. longer.

Models 50 and 52 have a power rating of 1.5 w at ambient temperatures up to 120 C, derating to 0 at 200 C. Helipot Corp., Newport Beach, Calif.

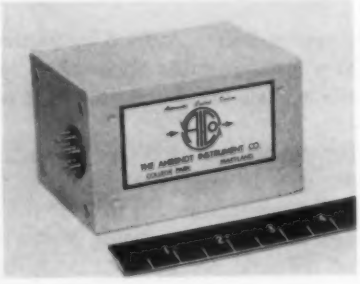
For more information—
Circle 38, inside back cover



Fhp Electric Motor

Available either ventilated or enclosed and with ball or sleeve bearings. Windings of Model M-20 are universal or shunt, of Model M-100, permanent magnet (d-c shunt). Voltage is 6 to 220 v a-c, (d-c or d-c shunt.) Ratings 1/30 hp, continuous duty. Shaft diameter is $\frac{3}{8}$ in. max., weight, 2 lb. Rae Motor Corp., 2009 Kewaunee St., Racine, Wis.

For more information—
Circle 39, inside back cover



Magnetic Amplifier

Designed for self-contained, 400-cps input signals, this magnetic amplifier is adaptable to input signals from d-c to 1000 cps with the addition of a reference transformer. Suitable for driving BuOrd Mk 7 or Mk 8 servo motor or equivalent. Does not require any vacuum tube or transistor driving stage in a normal servo loop. Circuit is of full-wave design. Ahrendt Instrument Co., 4910 Culvert Road, College Park, Md.

For more information—
Circle 40, inside back cover

Proximity Control Unit

A proximity pickup control unit that permits the use of a standard electrical plug rather than a microphone connector at the output is wired for 155 v a-c up to 60 w through an internal relay. The relay is a single-pole, double-throw type with contacts rated at 5 amp, 115 v a-c non-inductive load. It is reported to operate at speeds up to 600 operations per minute. The unit measures $2\frac{3}{8}$ x $4\frac{3}{8}$ x 8 in. Electro Products Laboratories, Inc., 4500 N. Ravenswood Ave., Chicago 40, Ill.

For more information—
Circle 41, inside back cover

Nuclear Power Packs

A family of small, light nuclear power packs said to have a shelf and use life of over 25 yr and capable of operating over wide ranges of temperature, acceleration and vibration deliver energy pulses up to 337,000 ergs. Sizes range from less than 1 to 2 cu in. They are supplied encapsulated in a metal case and are provided with standard connectors.

This battery converts nuclear energy directly into electrical energy. It is made with current ratings from 5 to

CONTINUED ON PAGE 234

USING

DU PONT ELASTOMERS

neoprene · Hypalon®

in design

Neoprene boot and seal help simplify design of new helicopter's rotor system

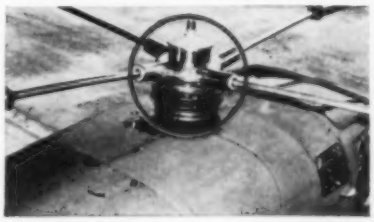
Hypalon®-coated convertible tops resist sunlight, weathering, discoloration

Longer service life and far easier maintenance are the advantages of HYPALON-coated convertible tops. Coatings of this new Du Pont synthetic rubber resist weathering . . . stay flexible at temperature extremes. They permit a wide variety of colors for the tops, too. HYPALON can be compounded in a complete range of durable, light-stable colors that stay bright for years.

These tops don't soil readily, but when they do, they're easily cleaned with soap and water. The reason: HYPALON doesn't depend on plasticizers for flexibility . . . so no sticky plasticizer oozes to the surface in hot weather to pick up dirt.

This is just one of many commercial applications of HYPALON. Other products, such as conveyor belts, take advantage of the heat resistance of HYPALON. It withstands hardening at elevated temperatures (250°-350°F.). And hose resists strong oxidizing chemicals . . . jacketing for wire is practically ozoneproof . . . when made with HYPALON. From coatings to molded parts, HYPALON offers you properties that assure extra-long service under extreme exposure conditions. Why not get full details? Just mail the coupon below.

RAISING AND LOWERING of the convertible top produces no cracks in the durable HYPALON coating. It resists flex cracking . . . stays flexible and firm despite years of outdoor exposure.

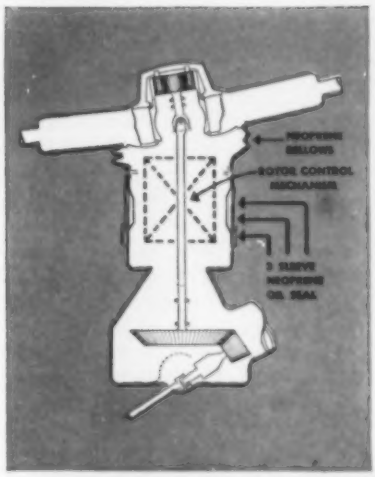


NEOPRENE SPECIFIED FOR RESISTANCE TO OIL, WEATHERING, TEMPERATURE EXTREMES

A step forward in helicopter design is achieved by a new rotor system which has some 1,200 fewer parts than contemporary designs. Doman Helicopters, Inc., Danbury, Conn., claims that maintenance time is slashed by 75%. As many as eight man-hours of maintenance for each flight hour have previously been required.

The unique feature of the helicopter is that its rotor hub can be tilted in any direction. To make the hub tiltable, the designer had to have a flexible housing for the rotor control mechanism. He specified neoprene. The upper part of the housing is a neoprene bellows, which serves not only as an enclosure, but also as an annular universal joint through which the control mechanism is driven. The bellows has a ¼-inch wall thickness and is designed for torsional rigidity and vertical flexibility. Lower part of the housing is a three-sleeve labyrinth oil seal also made of neoprene.

Neoprene was chosen for its combination of properties. On the outside, the housing needs neoprene's resistance to sun, weather and ozone. On the inside, the housing material must withstand the hot oil (225°F.) that bathes the entire rotor control mechanism.



NEOPRENE BELLOWS permits entire rotating hub of helicopter to be tilted in any direction . . . provides protection in all positions. Neoprene labyrinth oil seal bellows eliminates multiple grease fittings.

This oil-bath lubrication system has some advantages of its own. It has eliminated grease fittings and has simplified maintenance. The manufacturer says mechanics can peel back the bellows and seal and dismantle the gears and drive shaft within 20 minutes.

MANY DESIGNERS have found neoprene the ideal answer for a resilient material that must resist flame, flex cracking, chemicals . . . or any of the many exposure conditions that an ordinary rubber product cannot withstand. Why not get all the facts about neoprene? Just mail coupon below for complete information.

DU PONT

REG. U.S. PAT. OFF.

HYPALON *is a registered trademark of E. I. du Pont de Nemours & Co. (Inc.)*

BETTER THINGS FOR BETTER LIVING . . . THROUGH CHEMISTRY

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E. I. du Pont de Nemours & Co. (Inc.)
Elastomer Chemicals Dept. PE-3
Wilmington 98, Delaware

Name _____ *Position* _____

Firm _____

Address _____

City _____ *State* _____

5000 micro-microamp and equilibrium voltages in the order of 10,000 v. Battery performance is not affected by environmental conditions, and shelf and use life are not changed by short circuiting. The constant current characteristic of the nuclear battery is used to charge a capacitor, making available a pulse source of electrical energy of essentially zero impedance. Pulse energy may be used repeatedly and means are provided to reliably regulate capacitor voltages at specific values between 75 and 750 v. Patterson Moos Div., Universal Winding Co., 90-28 Van Wyck Expressway, Jamaica 18, N. Y.

For more information—
Circle 42, inside back cover

Remote Integrating Counter

A remote integrating counter for use with pneumatic transmission systems receives its signal from a measuring transmitter, which operates on an impulse duration system. Since the electric signal transmitted is a function of time, line voltage variations do not affect the accuracy of the counter. The counter is housed in a small flush mounting case for use near a pneumatic recording or indicating receiver on a panel board, or in whatever location its use would prove most valuable. Bristol Co., Waterbury 20, Conn.

For more information—
Circle 43, inside back cover

Single-Turn Potentiometer

The resistance element and terminal leads are molded into a single unit for better operation under severe vibration and high temperature conditions. Units may be ganged, and

each cup may be individually phased in the field. All models have ball-bearing mounted shafts.

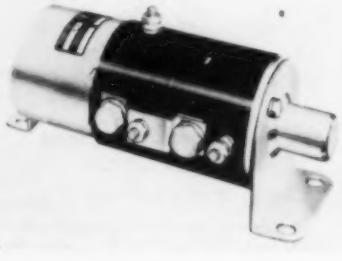
The potentiometer has a power rating of 5 w at 40 C, and a resistance range of 50 to 10,000 ohm, standard tolerance ±5 per cent. Standard linearity accuracy is ± 0.5 per cent independent. Starting torque is 0.5 in-oz per section. Continuous mechanical rotation, 340 deg or less electrical rotation.

Net weight is 4 oz per single unit, with 1 oz added for each additional unit. Dimensions of a single unit are 1 3/64 x $1\frac{7}{8}$ in. Shaft is $\frac{3}{8}$ in. long with special lengths available. George W. Borg Corp., Janesville, Wis.

For more information—
Circle 44, inside back cover

Heavy-Duty Parallel Switches

These units make possible the use of 24 v for starting motors on vehicles and engines having 12-v electrical systems. They are applicable to trucks, buses, tractors and other off-highway equipment, industrial, marine and railroad engines with cranking motors up to 20 hp and generating systems up to 180 amp. A single series-parallel switch replaces two switches in the



usual series-parallel system with Bendix drive.

Either splashproof or waterproof construction is available, and a special design prevents short circuiting from contact welding, and thus, the elimination of fuses or circuit breakers. Leece-Neville Co., 1374 E. 51 St., Cleveland 3, Ohio.

For more information—
Circle 45, inside back cover

Potentiometer for Severe Environments

Resistance is 30,000 ohm, ± 10 per cent; linearity ± 0.2 per cent; resolution, 0.001 in.; power dissipation up to 2 w. This model withstands temperatures from −65 F to 275 F; vibration 10G, 10 to 1500 cps; and shock up to 60G. Weight is approximately 2.5 oz. Its travel distance is 4.13 in. Humphrey Inc., 2805 Canon St., San Diego 6, Calif.

For more information—
Circle 46, inside back cover

Plug-In Scaler-Counter

Using a pair of magnetic cores as count-determining elements, this device operates from d-c to 50 k. The scaler is designed for applications including frequency division, random counting, preset counting, accumulators and television sweep synchronizing. Scales of 9, 10 and 11 are presently available.

Overall size is $3\frac{1}{4}$ x $5\frac{1}{2}$ x $1\frac{1}{4}$ in. Requirement is 150 v at 15 ma and 6.3 v at 0.3 amp. Two outputs provide 40 v at high impedance and 4 v at low impedance. Magnetics Research Co., 255 Grove St., White Plains, N. Y.

For more information—
Circle 47, inside back cover

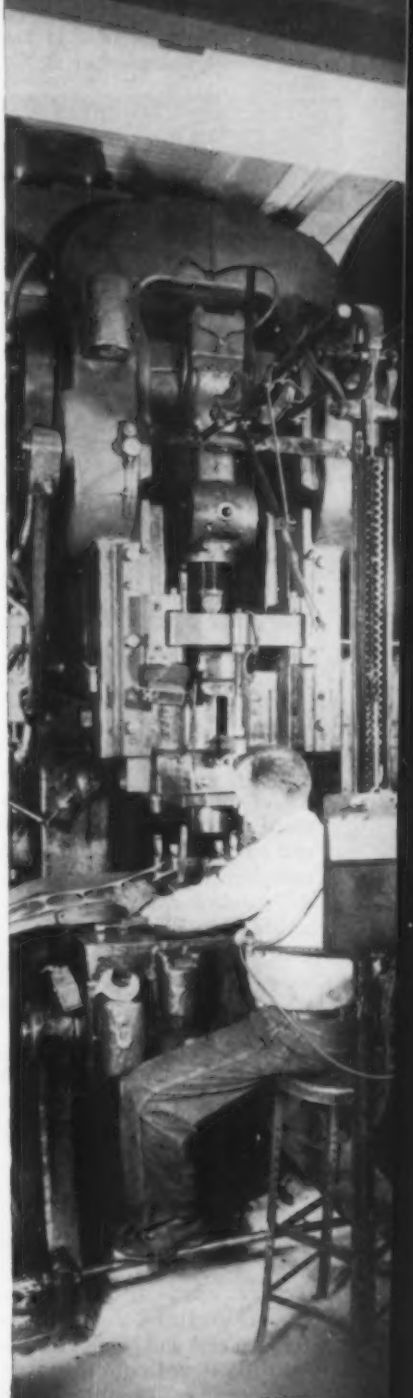
Magnetostrictive Delay Line

A delay line with ten pickup coils has a range of from 2 to 40 microsec while providing for ten continuously adjustable outputs. Each pickup coil slides along the calibrated slot and is locked in place by its knurled thumbscrew. As many as 20 pickup coils

—CONTINUED ON PAGE 236

pre-planned

results



In estimating production costs, one of the items a metal fabricator takes into account is the cost of steel. As important as this is, it is sometimes good economics to pay more for steel, but pay less in the end for the fabricated part. The cost of down time on expensive forming equipment, the cost of idle labor, the cost of reprocessing defective parts, may well exceed the cost of the extras built into restricted specification steel, which will eliminate these unplanned-for costs.

CMP restricted specification cold rolled strip steel can be pre-planned to minimize production delays and produce for you the production cost you need. We will welcome the opportunity to explore with you the cost-saving potentials in your manufacturing processes which may be available to you by use of **CMP** restricted specification cold rolled strip steel.

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WHERE YOU CAN GET SPECIFIC SPECS FOR SPECIFIC JOBS

LOW CARBON, ELECTRO ZINC COATED, HIGH CARBON, TEMPERED SPRING STEEL, STAINLESS AND ALLOY

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RESTRICTED SPECIFICATION COLD ROLLED STRIP STEEL boosts production, stops slow-downs, reduces die costs, meets feed and speed requirements of automatic equipment.

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STRIP PROVIDES the precision dimensional and physical qualities that solve many fabrication, cost and performance problems.

can be accommodated in the standard design and case without noticeable reduction of output due to loading. The closest juxtaposition is about 2 microsec.

Input impedance, 50 ohm; output, 500 ohm. With as many as 20 pickup coils included, there is still room for a slight amount of individual variation; but for more than 20, or closer juxtaposition of pickups, a special model is required. Deltime, Inc., 608 Fayette Ave., Mamaroneck, N. Y.

For more information—
Circle 48, inside back cover

Variable Speed Motors and Gearmotors

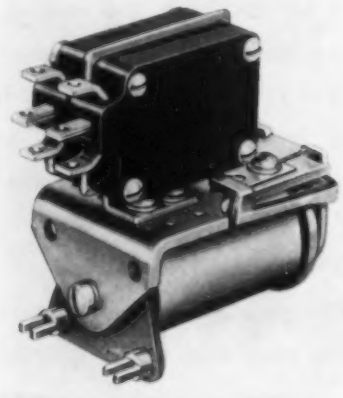
Gear motors and variable speed motors with reducers have been developed for severe radial load duty. This is accomplished through extended bearing construction on the speed reducer. Ratings now available, and others on the drawing board, will complete the line through 15 hp. All standard AGMA speeds are furnished from 350 through 20 rpm, in both constant and variable speed models. Sterling Electric Motors, Inc., 5401 Telegraph Road, Los Angeles 22, Calif.

For more information—
Circle 49, inside back cover

Temperature Control for Corrosive Solutions

A temperature control unit that is immune to corrosion problems such as occur in plating, anodizing, and pickling solutions uses a heat exchanger inserted into the suction line between tank and pump. The thermal bulb is strapped onto the insert pipe and covered with insulation. The bulb does not impede the flow nor come in contact with the solution; therefore, corrosion cannot attack either the bulb or capillary tubing. Two models are now available. Series P includes indicating dial showing actual tank temperature. Series R does not indicate. Both models are knob-set on controller for desired temperature. Carl Buck & Associates, Essex Fells, N. J.

For more information—
Circle 50, inside back cover



Miniature Snap-action Relay

This relay has enclosed contacts and a contact rating of 10 amp at 115 v a-c, non-inductive load. Can be furnished with one snap-action switch for single-pole, double throw contacts or with two switches for double-pole, double-throw contacts. Also available with plug-in mounting. Furnished for d-c operation to 230 v, 60 cps a-c to 440 v. Approximate dimensions, $2\frac{3}{8}$ x $1\frac{7}{8}$ x $1\frac{1}{8}$ in. wide. Magnecraft Electric Co., 3350Y W. Grand Ave., Chicago 51, Ill.

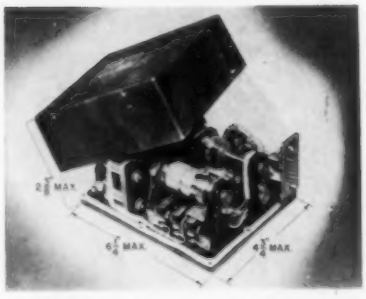
For more information—
Circle 51, inside back cover

Pulse-To-Analog Converter

This is an electro-mechanical shaft-positioning device which provides controlled incremental shaft rotation of one 2-deg step per d-c pulse. Rotation is unlimited clockwise or counter-clockwise, and stepping speed is as rapid as 60 steps per second with torque output as high as 14 in-oz. Between pulses, shaft position is locked in an accurate shaft angle by

a spring detent. Nominal input of 1 amp at 28 v d-c for a pulse duration as short as 10 milli-sec will accomplish one 2-deg step. Optional control mechanisms available on standard models provide homing to a fixed reference position, automatic continuous stepping with the application of a steady d-c voltage, and/or potentiometer output proportional to shaft position. G. M. Giannini & Co., Inc., 918 E. Green St., Pasadena, 1, Calif.

For more information—
Circle 52, inside back cover



Multiple Sequence Timer

A six-in-one, multiple-contact timer handles up to six separate in-sequence operations simultaneously. Switches can be actuated by a magnetic clutch and cam arrangement which re-sets to zero upon completion of timing cycle or in the event of power failure to the unit. In addition to the clutch-actuated switches, the timer contains five continuously pulsating switches one of which continuously operates in a closed position for 0.050 sec (±0.010 sec) and open for 0.450 sec (±0.040 sec). Switches operate under 0.250 amp load at 115v, 400 cps, over an input voltage range from

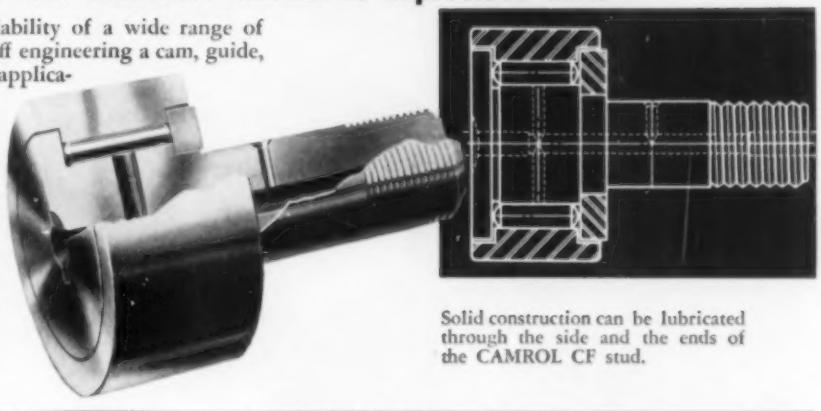
CONTINUED ON PAGE 238

BEARING TIPS by McGill

For convenience, with savings in time and cost

Use McGILL® CAMROL Cam Followers instead of improvised units

Simplification of design with availability of a wide range of standard bearings takes the strain off engineering a cam, guide, support or track roller bearing application. No need to "build up" a special unit when you can select the proper size standard CAMROL bearing engineered especially for the job. McGill's CAMROL bearing construction offers full type capacity, with provision for shock, in a compact precision unit. Specify CAMROL, the original cam follower, in either CF (with stud) or CYR (shaft mounting) series. Sealed and prelubricated bearing available also.



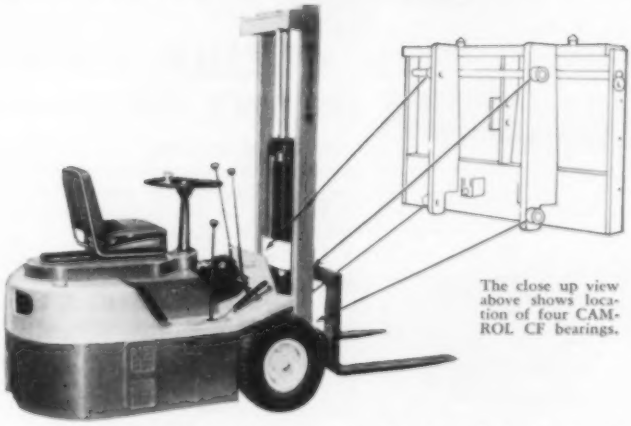
Solid construction can be lubricated through the side and the ends of the CAMROL CF stud.

YR bearings help F-100 Super Sabre make slower and safer landing

The supersonic speeds obtained by today's modern aircraft set up design problems not encountered with older, slower planes. The overall streamlined design required for speed in flight, for instance, necessitated finding ways of supporting the North American F-100 Super Sabre at low air speeds required for landing. A

series of slats on the leading edge of the wing, providing greater lift at lower air speed, was the answer. Each slat is supported by McGill CAMROL YR bearings — especially designed to permit shaft or yoke mounting. These long-life bearings carry the loads of these slats as they move on tracks during flight of the Supersonic F-100.

CAMROL CF bearings out-perform friction rollers as fork support bearings



The close up view above shows location of four CAMROL CF bearings.

Small size and high load-carrying unit construction with simplified lubrication are among principal benefits obtained by Hyster Company from use of CAMROL CF bearings as fork support rollers in its Hyster 20 and other lift trucks.

Two bearings ride up and down inside each vertical mast section to position the lift truck fork under load. Speeds are relatively slow but the crushing loads on each bearing are heavy.

In this particular application, the exterior surfaces of the bearings are treated with a black oxide finish. This provides corrosion-resistance which serves to augment maintenance-free operation, a characteristic of CAMROL bearing construction.

Fact-packed Bearing Catalog

Write for your copy of Catalog 52-A, a revised, 128-page Bearing Selection Guide.

Insure performance with McGILL®

MULTIROL® GUIDEROL® CAMROL®
Precision Needle Bearings

McGILL MANUFACTURING COMPANY, INC., 201 N. LAFAYETTE ST., VALPARAISO, INDIANA

GEARS by FAIRFIELD

A Plus Value IN ANY PRODUCT!

If GEARS are a vital part of the product you make, there is no finer recommendation for the QUALITY of your product than to be able to say it is equipped with "FAIRFIELD GEARS."

Long producers of the gears needed in high grade trucks and tractors, Fairfield now brings the same standards for GEAR PERFORMANCE to a wide variety of products: Agricultural Implements . . . Power Shovels . . . Machine Tools . . . Diesel Locomotives . . . Road Graders . . . Lift Trucks . . . Road Rollers . . . Pump Drives . . . Winches . . . Military Vehicles . . . and a host of others.

Fairfield's facilities are unexcelled. Here "under one roof" in a new and ultra modern plant, Fairfield has everything needed for producing all kinds of gears: spur . . . herringbone . . . spiral bevel . . . ground tooth spiral bevel . . . straight bevel . . . coniflex bevel . . . hypoid . . . zerol . . . worms and worm gears . . . splined shafts . . . differentials. Get acquainted with Fairfield — your inquiry will receive prompt attention.

Send for illustrated bulletin describing Fairfield's facilities.

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2305 S. Concord Rd.,
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For FINE GEARS

24 to 30 v d-c. Dimensions are 6¼ x 4¾ x 2⅜ in. height. Weight is 4 lb. John Oster Mfg. Co., Avionic Div., Racine, Wis.

For more information— Circle 53, inside back cover

Stepping Synchro

Using an electro-mechanical positioner to drive the rotor of a differential synchro in fixed increments of 1 deg, these highly accurate instruments produce an a-c output that is synchronous with rotor position. Rotation of the mechanism is unlimited in both directions, and is operated by an electrical input pulse at any speed up to 60 deg per sec.

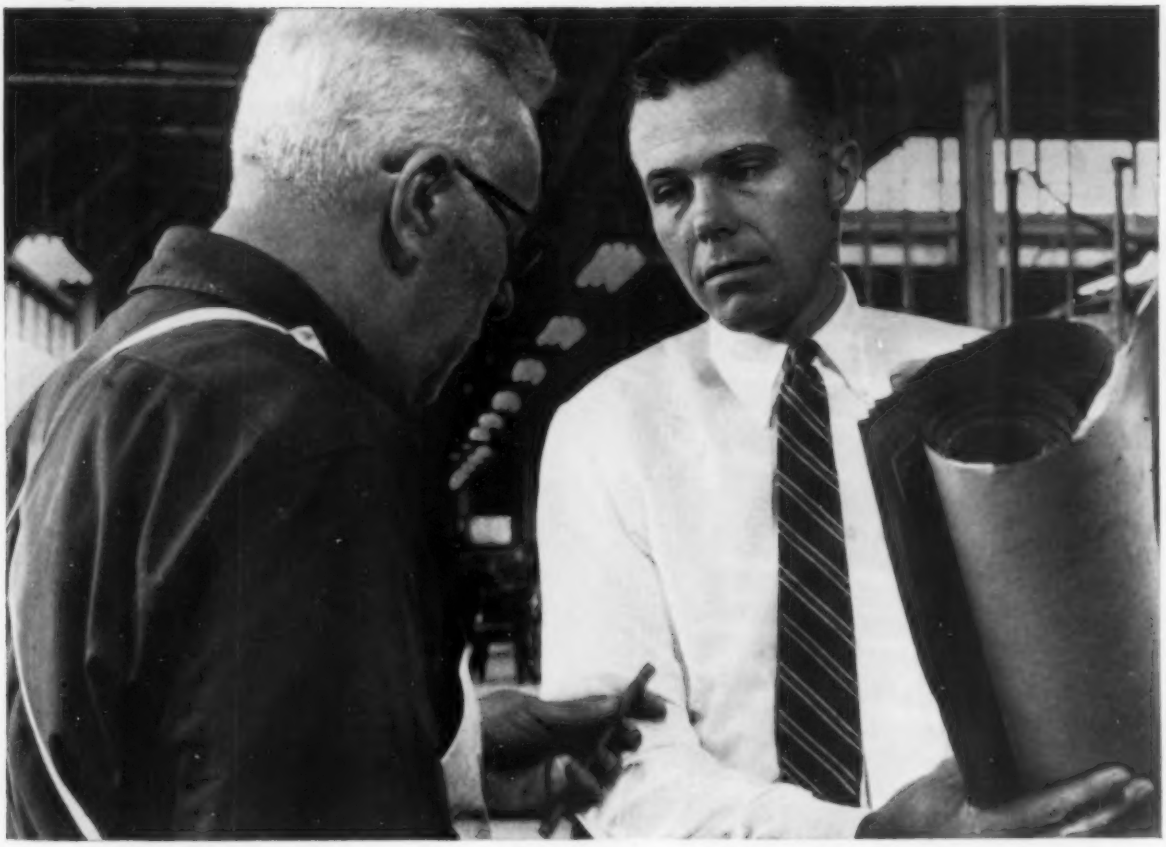
The shaft output of this manufacturer's pulse-to-analog converter is adapted to position accurately the rotor of the precision differential synchro. G. M. Giannini & Co., Inc., 918 E. Green St., Pasadena 1, Calif.

For more information— Circle 54, inside back cover

Totalizing Counters

Any electrical, mechanical or optical event which can be converted into electrical impulses can be totalized. Transducers to effect impulse conversion can be photocells, magnetic coils or switches. Models are available with

(Continued on page 240)



Don't let your blueprints take the blame

TOO OFTEN costly production errors are blamed on hard-to-read blueprints. The real culprits, of course, are the old smudged drawings from which the prints were made.

However, a simple step makes such drawings capable of producing sharp, legible prints—*reproduce them on Kodagraph Autopositive Paper.* This photographic material gives you positive intermediates *directly* (no negative step)—sparkling intermediates even from soiled or weak-line originals.

Unlike your valuable drawings, they won't smudge or lose line density when used as "masters" in your print machine. They assure easy-to-read prints time after time—*pays you to make one of every drawing!*

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from 1 to 4 decades. Their count capacity ranges from 999,999 to 999,999,999. Counts per second range from 0 - 150 to 0 - 100,000. Input requirement is 0.05 v rms. Computer - Measurements Corp., 5528 Vineland Ave., N. Hollywood, Calif.

For more information—
Circle 55, inside back cover

Temperature Sensing Element

Designed for use with automatic aircraft temperature control systems, these sensing elements feature two independent resistance circuits. They are said to be especially suitable for high temperature, high pressure duct application.

Operating temperature range is –65 F to 600 F. Mating electrical connector limits maximum ambient temperature. Versions are available for operating temperatures up to 1000 F. Units can be supplied with flange or pipe thread mounting. Unit shown is 2⅛ in. long and weighs 1 oz. Barber-Colman Co., 1400 Rock St., Rockford, Ill.

For more information—
Circle 56, inside back cover

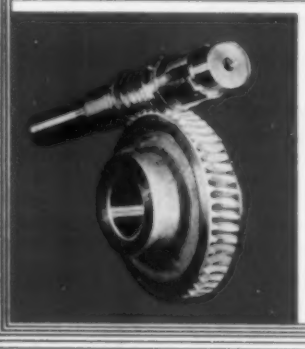
Magnetic Amplifier Controllers

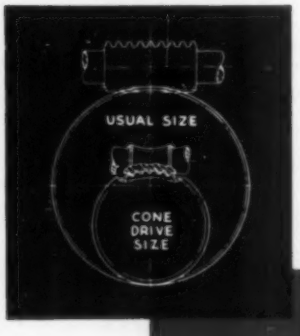
These instruments are said to be insensitive to normal shock and vibration, eliminating the extra cost and weight of shock absorbing equipment. Multiple isolated control circuits are possible, and input circuits can be completely isolated from output circuits.

Power requirements for an on-off control are 0.5 w, 100-120 v, single-phase, 380 to 420 cps. Input resistance is 270 ohm. Maximum sensitivity is 0.07 microw. Operating tem-

(Continued on page 243)

for concentrated power





. . . CONE-DRIVE gearing has no equal.

You can pass an amazing amount of power through a set of Cone-Drive gears.

Want to cut product size? Cone-Drive will give you a more compact gear train with reserve load capacity.

Want to boost power output and hold size? That's easy with Cone-Drive gears. They'll carry two, three, and four times the load of cylindrical worm gearing.

Why? In Cone-Drive gears, the load isn't concentrated on a small area per tooth or on just one or two teeth at a time. Cone-Drive's exclusive double-enveloping principle distributes the load over a lot of teeth and over more area on each tooth.

It cuts the unit loading the same way a pair of snowshoes supports a heavy man.

Ask for Bulletin CD-400 for complete details.

CONE-DRIVE GEARS
A Division, Michigan Tool Company
DOUBLE ENVELOPING GEAR SETS & SPEED REDUCERS
7171 E. McNichols Road • Detroit 12, Michigan

NEW ACTIONATOR*

heavy duty electric motor for operating valves, dampers, louvers

The new Honeywell ACTIONATOR* is a compact, lightweight, rugged and flexible industrial motor for operating valves, dampers, louvers, and other final control elements. Models for boss mounting or with integral valve yoke for installation on slip stem valves. Internal strain release protects valve seats and gear train. Squared shaft ends facilitate actuating lever attachment.

The ACTIONATOR is available in reversing or unidirectional models for on-off or two-position control, and in reversing models for floating or proportional control. Shaft rotation can cover up to 350 degrees in 7½, 10, 15, 30, 60, or 120 second timings, depending on model; torque ratings to 200 pound-inches, depending on motor speed.

The proportional control model provides slidewire resistances of 135, 500 and 1000 ohms, and can be used with any type of proportional controller. A second slidewire can be used for retransmission, to operate another motor, or for remote indication. If preferred, SPST and SPDT auxiliary switches can be installed within the end bells. The enclosed terminal compartment is designed to meet J.I.C. standards.

Specially designed MICRO SWITCH switches allow the ACTIONATOR to be used where ambient temperatures range from 25 to 150 F.

For complete information and specifications on the new ACTIONATOR, call the nearest Honeywell office, or write (send coupon) to:

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Phila. 44, Pa.

Industrial Division
MINNEAPOLIS-HONEYWELL REGULATOR CO.
Wayne and Windrim Avenues, Philadelphia 44, Pa.

☐ Please send me additional information on the ACTIONATOR.

☐ I'd like a Honeywell sales engineer to discuss applications of the ACTIONATOR in my plant.

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MINNEAPOLIS Honeywell

First in Controls

*Tradename Minneapolis-Honeywell Regulator Co.

NEW

from MEYERCORD

NAMEPLATE DECALS

If you have adhesive problems with the water applied decals you are now using...switch to NEW MEYERCORD TYPE I

This is BIG NEWS about a new addition to the Meyercord "family" of commercial nameplate decals! Meyercord has perfected a completely new water applied decal nameplate with revolutionary advantages.

This new TYPE I Decal instantly grips virtually any commercial surface with bulldog tenacity. It will cling and adhere with ease to acrylics, metal (painted or unpainted), melamines, polyethylenes . . . to mention only a few of the more difficult.

TYPE I Decals are applied with all the usual ease of any water applied decal but they do not depend upon water solubility for adhesion. Even if oversoaked for long periods there is no damage or adverse effect on the adhesion. TYPE I Decal Nameplates can be designed to include colorful halftones as well as plain poster-style designs. However, for the present, this new TYPE I Decal can be manufactured in production line quantities only.

Let us prove that TYPE I can be the answer to the most stubborn nameplate problem. Send sample of surface and material—for samples and full information. Request on company letterhead. No obligation.

THE MEYERCORD CO.
World's Largest Decalcomania Manufacturers
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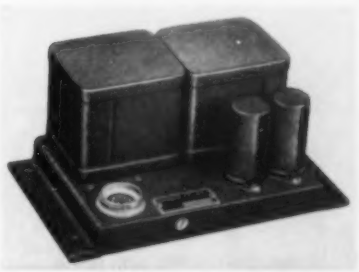


perature range is –65 F to 250 F. Output relays are rated at 2 amp, 115 v a-c or 28 v d-c, non-inductive (higher ratings available). The box, pictured, for pulse-modulated, floating control, weighs 1.8 lb, without filters. An unfiltered box for on-off control weighs 1 lb. Barber-Colman Co., 1400 Rock St., Rockford, Ill.

For more information—
Circle 57, inside back cover

Slide-Wire Potentiometer

This high-temperature model has a power rating of 1.5 in. at 150 C. It is available with linearities of 0.1 and 0.05 per cent and standard resistance values of 50, 100, 150, 200 and 250 ohm per turn in 10-turn units. Other shaft rotations from 1 to 10 turns and other resistance values as low as 2 ohm per turn are also available. G. M. Giannini & Co., Inc., 918 E. Green St., Pasadena 1, Calif.

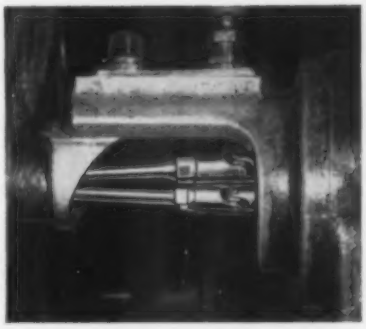
For more information—
Circle 58, inside back cover

Oil-Tight Pushbutton Switch

One of these new pushbuttons combines the functions of a single-button station with the advantages of a two or three-position selector switch. Contacts are maintained or momentarily

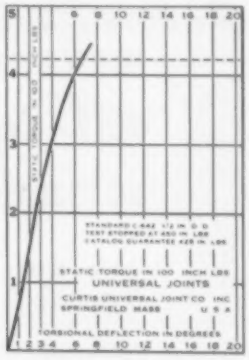
(Continued on page 246)

Solving a breakage problem AT CLOSE QUARTERS



The manufacturer of this button-drilling machine had a tough problem: the universal joints on these parallel shafts carried such a torque load there were frequent complaints of breakage . . . yet the close centers prohibited use of a larger joint.

THE SOLUTION was a Curtis Universal Joint of the same size.


STATIC TORQUE IN 100 INCH LBS
UNIVERSAL JOINTS
CURTIS UNIVERSAL JOINT CO. INC
SPRINGFIELD MASS U S A
TORSIONAL DEFLECTION IN DEGREES

Torque Curve ½" Curtis Universal Joint

This is only one of many problems solved by Curtis Joints – size for size the strongest universal joints designed for industry. Selected materials, precision engineering, and over 30 years' experience manufacturing universal joints make them that way.

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3/8" to 4" O.D. (6" joints on special order)

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EXCLUSIVELY A MANUFACTURER OF UNIVERSAL JOINTS SINCE 1919

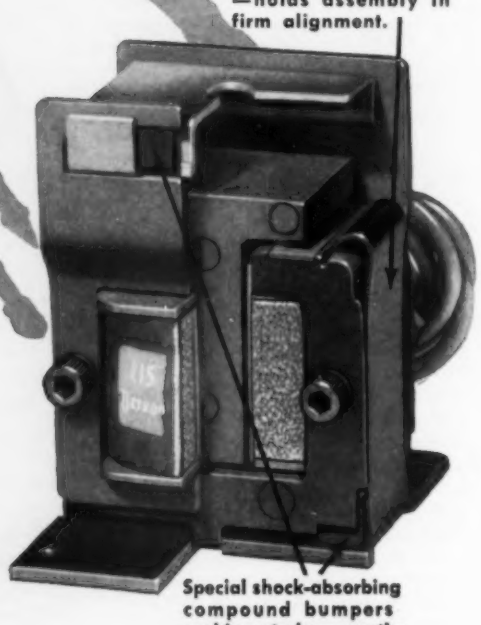
we've gentled the bucking bronco!

Decco two-way shock mounting greatly reduces self-destruction in your solenoids.

The greatest cause of solenoid failure is the impact on the solenoid structure of the unspent stroke force.

Decco recognized this problem years ago and engineered effective, two-way recoil material into the basic design. Decco's patented shock mounting is well known in industry. It is responsible, along with quality construction, for Decco Solenoid's substantially greater service life and a substantial saving of down-time and dollars to their users.

Decco engineers will be happy to discuss your solenoid requirements without obligation. Special solenoids engineered to your needs.



Tempered alloy steel spring absorbs vibration —holds assembly in firm alignment.

Special shock-absorbing compound bumpers cushion stroke—greatly improve the service-life of the solenoid.

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DETROIT COIL COMPANY

2435 HILTON ROAD, FERNDALE 20, MICHIGAN

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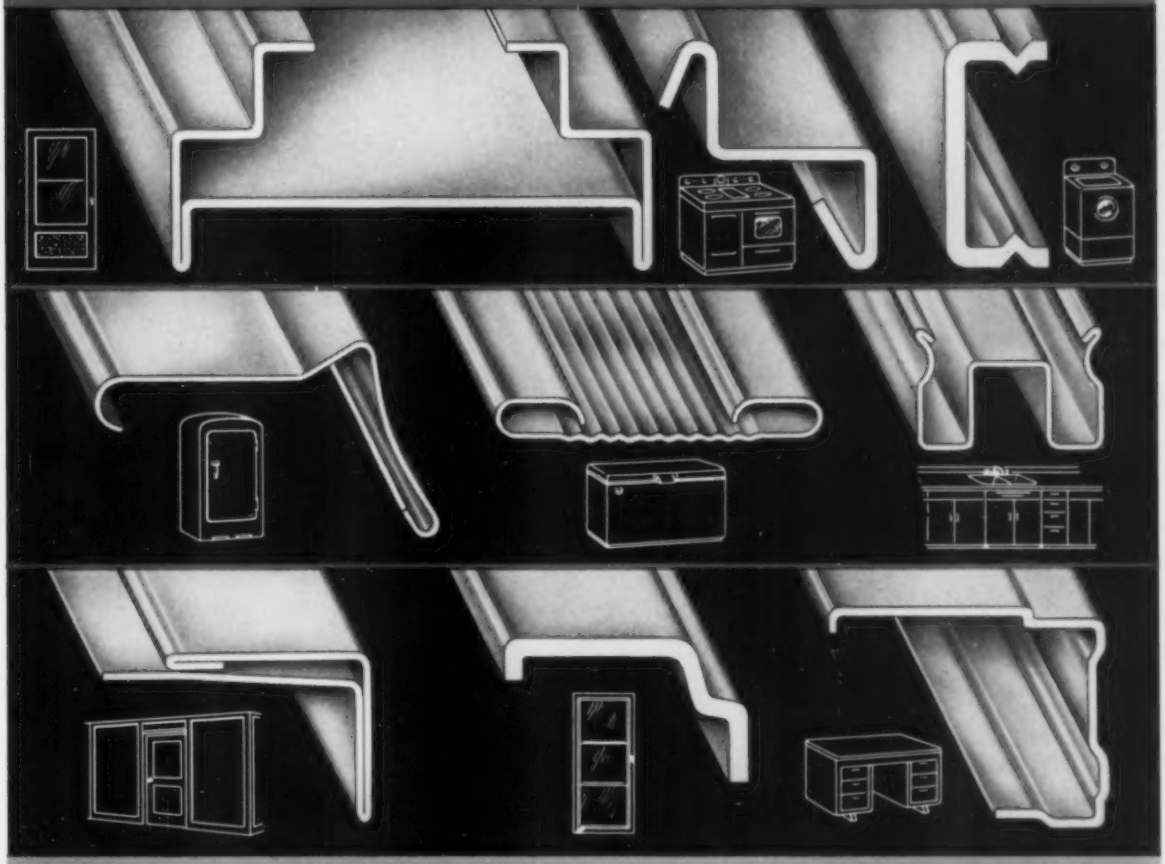
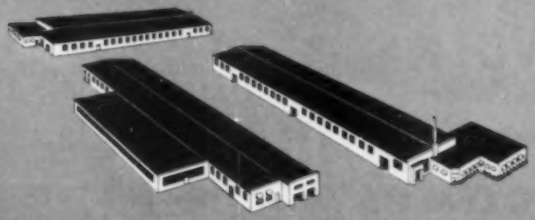
REDUCES TODAY'S PRODUCTION COSTS



Roll Formed manufactures metal shapes for all industries. We can engineer and produce your shapes and deliver them to meet your production schedules. Because of the accuracy of Roll Formed shapes your finished assemblies will cost you less. We produce simple and complex shapes in carbon, galvanized and stainless steel; aluminum, copper, zinc and clad metals. Uniformity, high production and less scrap hold our costs down. Send your prints and quantity requirements today. Let us show you how you can beat production costs with Roll Formed!



ROLL FORMED PRODUCTS COMPANY

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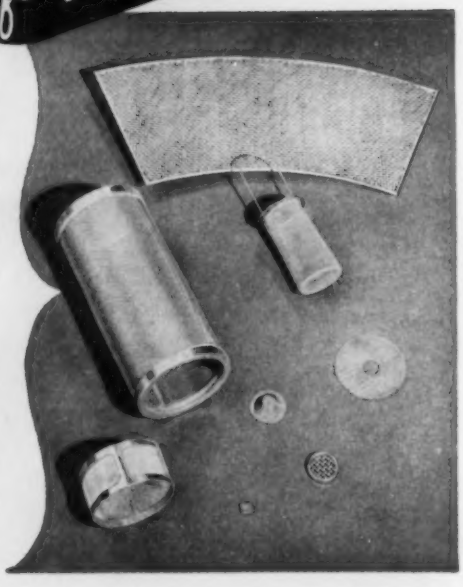
NEWARK for ACCURACY

applies also to "fabricated" wire cloth inserts



Our slogan, Newark for Accuracy, has long been known to users of bulk wire mesh cloth, wire space cloth and wire filter cloth. It is now becoming more and more familiar to users of parts fabricated from wire cloth made by a fast-growing division of our company.

These parts, similar to those illustrated, are fabricated or assembled for our customers by skilled workmen in our large department specializing in this work. We are equipped to handle small lots or in production quantities of anything from large jet intake screens to tiny fuel pump strainers

We shall be glad to quote on your requirements; and, if necessary, our experienced engineers stand ready to assist you in the design of the part so as to make the best use of the mesh and to assure the most economical manufacture of the part as a whole.

Remember, since we weave the cloth used, and do all the necessary cutting, fitting, stamping, punching, forming, binding, welding and soldering; there is only one responsibility . . . OUR responsibility . . . to deliver parts that live up to our slogan — Newark for Accuracy.

We can furnish wire cloth woven from all commercially used metals. Sizes range from 4 inches (space cloth) to 400 mesh.

Newark Wire Cloth COMPANY

351 VERONA AVENUE • NEWARK 4, NEW JERSEY

operated by either turning the guard ring, depressing the button, or a combination of both. The other device, an indicating light, provides a simple means of checking indicating lights without disturbing the control circuit and without removing a lens or bulb.

This line offers a back-of-panel depth of 1 23/32 in. for the transformer types and 1⅞ in. for the resistor units. They are available in key-operated, selector switch, flush, mushroom head or knob-operated models. Contact blocks are divided into two isolated compartments with individually operating plungers and circuits which can be both normally open, both normally closed or one normally open and one normally closed. Three of these blocks can be so arranged as to provide circuit flexibility. Cutler-Hammer, Inc., 296 N. 12 St., Milwaukee, Wis.

For more information—
Circle 59, inside back cover

Safety Switches

This is a line of safety switches meeting the new NEMA standards. Three types of switches are included: Type LD is for light duty. It replaces the former D or G types. It includes a full range from 30 to 200 amp in both general purpose and raintight enclosures. NEC horsepower ratings are included.

Type ND is for normal duty and commercial work. Replaces the former H, S, A, or C designations. The full line extends from 30 through 1200 amp in both 250 and 600 v a-c and d-c, in both general purpose or raintight enclosures. Both NEC and dual element horsepower ratings are included.

Type HD is for heavy duty industry use. Enclosures include the gas-

(Continued on page 249)

DOW CORNING CORPORATION

Silicone News

FOR DESIGN ENGINEERS No. 36

Silicone Fluid Aids Performance of Oil Well Drilling Instrument

Dow Corning Silicone Fluids have proven ideal for a growing number of damping, lubricating and fluid-filling applications where temperatures exceed the limits of organic oils. A case in point is the magnetic detector developed by McCullough Tool Company of Los Angeles which pinpoints underground "stuck points" in oil well pipe strings.

In order to protect the detector's electric micrometer magnets and balancing mechanism against well fluids, high temperatures and extreme hydrostatic pressure, the entire unit is filled under vacuum with Dow Corning 200 Fluid.

Typical underground conditions are revealed by the following data recorded in locating a "stuck point" over 3 miles below the surface of the earth: Mud weight—133 pounds per cu. ft. with a viscosity of 70; Hydrostatic head — over 15,000 psi; Temperatures—in the order of 460 F.

In the face of these conditions, Dow Corning 200 Fluid efficiently equalizes pressures to keep the detector from collapsing. It also acts as a heat-stable capacitor dielectric and transformer oil. Voltages inside the detector run as high as 300 volts at 120 cycles per second on 1/16-inch spacing. *No. 367*

"DEW LINE" RELIES ON DRY-TYPE TRANSFORMERS INSULATED WITH DOW CORNING SILICONES

New testimony to the extra reliability of Dow Corning silicone electrical insulation is provided by the transformers of the "DEW" defensive radar line now under construction north of the Arctic Circle.

In these remote yet vital installations, dependability and maintenance-free service are essential. That's why Western Electric Company, prime contractor for "DEW" electrical equipment and installation, specified silicone insulated dry-type transformers right down the Line. Most of the units, supplied by the Pittsburgh works of Allis-Chalmers, have been installed.

Designed for maximum dependability, minimum weight and a 302 F (150 C) temperature rise, the transformers range in size from 25 to 75 KVA. They are completely sealed and will withstand ambient temperatures as low as —60 F (—51 C) when idle.

While used primarily for station light and power, the DEW Line silicone insulated transformers will handle power for the radar signal in an emergency. *No. 368*

Pre-painting Sheet Metal Stock with Flexible Silicone Finishes Reduces Cost of Finished Parts

Blank, shape and trim finished parts from pre-painted sheet metal stock? May sound impossible, but Taylor Instrument Companies report it can be done, and economically . . . providing you use a silicone-based paint.

In manufacturing a new and permanently colorful oven thermometer, Taylor engineers found they could reduce production costs by applying a silicone coating to the metal stock *before* rather than after forming or shaping. After a short heat cure, the silicone finish is flexible enough to withstand the shearing, blanking, (*Cont. Pg. 2*)

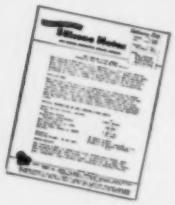
FOR DATA RELATING TO THESE ARTICLES, CIRCLE REFERENCE NUMBER IN COUPON ON NEXT PAGE

MORE

DOW CORNING CORPORATION

Silicone News

DOW CORNING PUBLICATIONS ON NEW DEVELOPMENTS AND TECHNICAL DATA . . . .



New Reference to Silicone Fluids describes the Dow Corning silicone fluids specified for most industrial and military applications. This convenient four page reference lists typical applications, and physical and electrical properties for each fluid — from flash point to volume resistivity. A useful and compact data source designed to help you select the silicone fluid most suitable for any specific application. *No. 371*

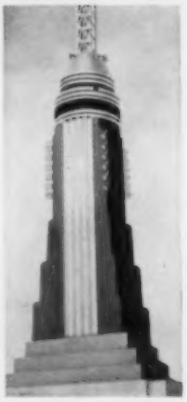
Low Pressure Laminating with Silicone Resins is a concise "how-to-do-it" manual that describes methods of making structural and electrical laminates for high temperature service. Also includes after-curing schedules. *No. 372*

"Rubber From Rock," a new color-sound movie, explains how Silastic, the Dow Corning silicone rubber, is manufactured from quartzite. Demonstrates why parts fabricated from Silastic retain rubber-like properties from —130 to over 500 F in a wide variety of military and industrial applications. Also covers uses for Silastic as a dielectric in electronic and electrical equipment. To arrange for a showing of "Rubber From Rock" in your plant, circle *No. 373*

All New—1957 Guide to Dow Corning Silicones is a twelve page, fact-filled reference describing the silicone products of interest to most industries. Containing latest data and information, the new 1957 Guide is designed expressly to help you enjoy the advantages, profits, and savings made possible through imaginative use of these versatile engineering materials. *No. 374*

"151 Uses for Silicones in Metalworking." A reprint from STEEL, condenses and lists known applications for silicones in Design, Production, Maintenance and Miscellaneous categories. Provides a quick but comprehensive review on how Dow Corning Silicones help solve problems in the metal-working industry. *No. 375*

Silicone-Glass Laminates Prove Stronger Than Ceramic Insulators



Although generally thought of only in connection with high temperature service, glass laminates bonded with Dow Corning silicone resins are superior in many ways to ordinary insulating materials at normal temperatures. Take low loss factor plus mechanical strength—

Since this combination of properties is usually attributed to ceramics, Andrew Corporation of Chicago used ceramic insulators when installing a special 4-corner television antenna for Station WATV atop the Empire State Building. But high winds and ice build-up on the antenna soon cracked the ceramic parts.

Andrew engineers then replaced all 240 ceramic insulators with silicone-glass laminate which is tougher than ceramic and not nearly as brittle. That was over two years ago and there hasn't been an insulator failure since! Engineers estimate the antenna will withstand a wind load of 50 psf with an inch thick layer of ice, or wind velocities up to 112 mph.

The superior mechanical strength of silicone-glass laminate is revealed in comparison tests conducted by Andrew engineers. Under cantilever loads, ceramic insulators cracked at 175 pounds and broke away at 235 pounds. Under similar conditions, the silicone-glass laminate was still holding well at 425 pounds. The tests were abandoned at this point because the quarter-inch stainless steel hold-down bolts were stretching out of shape.

Silicone-glass laminates also have excellent dielectric properties as shown by their qualifications for MIL-P-99713 in the following table. *No. 369*

Property	*Condition*	*Average Value*
Dielectric break-down parallel to laminations, step-by-step test, kv	A D-48/50	33-100 15-55
Dielectric strength perpendicular to laminations, step-by-step test, volts per mil	A	162-397 (1/8 inch thickness)
Dielectric constant at 1 megacycle, 1/8-inch thickness	E-96/50 D-24/23	3.8-3.59 4.2-3.56
Dissipation factor at 1 megacycle, 1/8-inch thickness	E-96/50 D-24/23	0.0025-0.0014 0.022 -0.0029
Insulation resistance, megohms	E-96/50 D_1-96/50 C-96/35/90	100,000-713,000 0.44- 7,510 2.38-10,000

FLEXIBLE SILICONE FINISHES *(continued)*

perforating and forming required to produce finished parts.

Taylor uses three colors of silicone paint —beige, green and red—formulated by the Stanley Chemical Company. The beige finish on the sandblasted steel thermometer case is cured for one hour at 450 F; the green finish on the alkaline-etched aluminum dial and the red finish on the bright-dipped brass pointer are each cured 30 minutes at 450 F.

Stanley Chemical recommends the silicone paints used by Taylor for use at temperatures up to 500 F. Other finishes formulated with Dow Corning silicone resins maintain excellent film integrity despite weathering, prolonged exposure to moisture, corrosive atmospheres and temperatures up to 1000 F. *No. 370*

Dow Corning Corporation, Dept. 8615, Midland, Michigan

Please send me: 367 368 369 370 371 372 373 374 375

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SILICONE NEWS is published for product design and development engineers by

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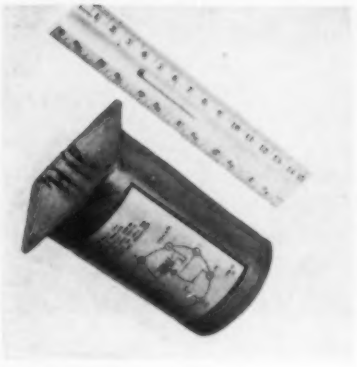
keted industrial (NEMA 12) type as well as watertight and dusttight, and explosion-resisting types. Square D Co., 6060 Rivard St., Detroit 11, Mich.

For more information—
Circle 60, inside back cover



Motorized Time Delay Switch

A miniature motorized time delay switch, accommodating up to five single-pole, double-throw switching functions, has a timing accuracy of ±5 per cent of a total timing cycle under all conditions. Size is 2⅞ x 4⅛ in. long on the largest units.

Normal delays are from 15 to 30 sec with instantaneous reset when power is removed. Unit is hermetically sealed—connecting wires are soldered to terminals extending through a glass back plate. These time delay switches operate on a range of d-c voltages from 6 to 50 v. Power input is 15 w for the motor, 7 w for the clutch.

At the end of the timing cycle the motor stops automatically, with switch position maintained by a clutch.

(Continued on page 252)

asg
UNIVERSAL JOINTS

available in 13 sizes
with bored or solid hubs

You can get ASG Universal Joints directly from stock in 13 sizes with bored or solid hubs ranging in diameter from .375" to 4.000". Special bores, bores with keyways or setscrews are available upon special order.

ASG Universal Joints are ruggedly constructed of heat treated alloy steel. Matching or mating parts are precision ground to permit easy interchangeability of components. Self-locking retaining rings on small pins simplify assembly and disassembly. Joints of 7/8" length and longer have snap ball oilers. Smaller joints have oil holes. Oil enters at center of rotation to assure thorough lubrication of moving parts.

Send today for Bulletin No. 527 describing the full line of A.S.G. Universal Joints available from your nearest distributor.

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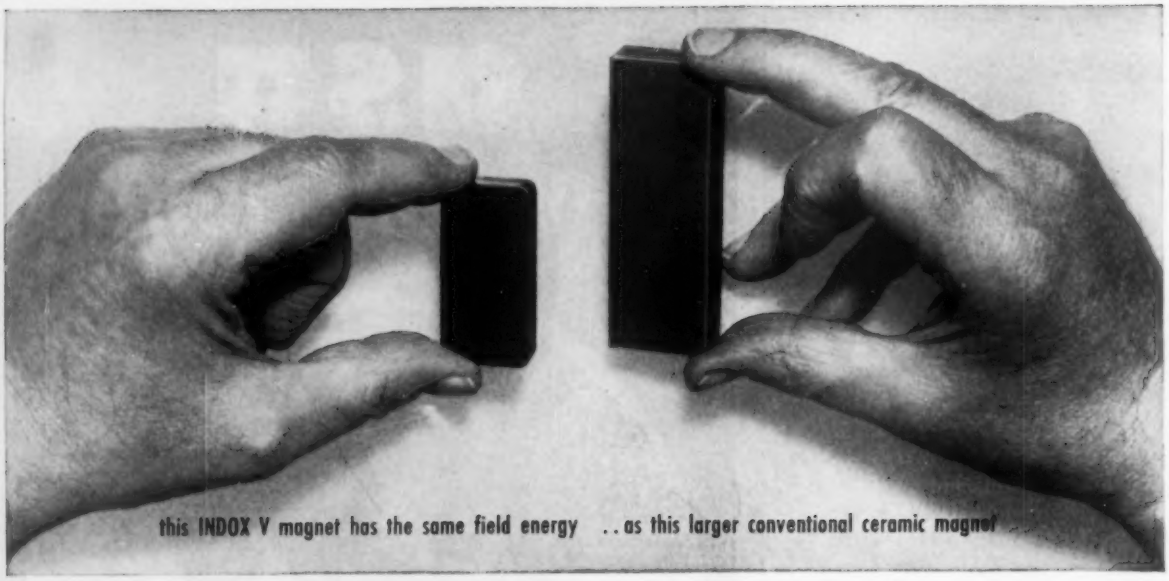

NEW, high energy Indox V ceramic permanent magnets

..they're 3½ times stronger than conventional ceramic magnets

Indox V — another first from the research and development laboratories of The Indiana Steel Products Company — is available to magnet users *immediately*. This unique, new, magnetic material offers these important advantages . .

Indox V requires no critical materials. It is a highly oriented barium ferrite . . using inexpensive, noncritical, raw materials that are constantly available. Shortages in times of emergency cannot occur.

Indox V requires less space, weight to do same job. Volume and weight comparisons show that the energy of Indox V far exceeds Indox I . . and is comparable to Alnico V, the strongest permanent magnet material commercially available.

Indox V offers high resistance to demagnetization. Indox V magnets can be designed for applications where extremely high demagnetizing forces exist . . without irreversible losses occuring. This means it can be used where other types of magnets have been impractical . . for example, in stators of medium-size electric motors where electromagnets are now being used.

..ideal for:

- D-C motors
- Synchronous drives
- Traveling wave tubes
- High-fidelity loud-speakers
- Eddy current drives
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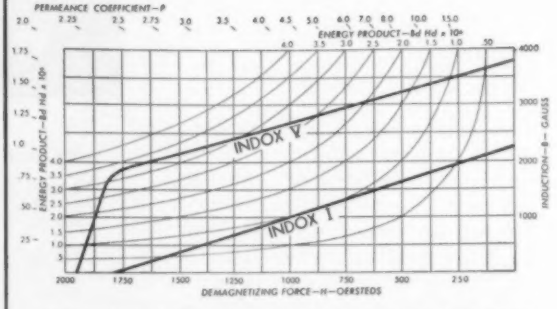

Comparison of demagnetization and energy product curve for conventional Indox I ceramic magnets and the new, high energy Indox V magnets.

JUST PUBLISHED! *This two-page data sheet gives detailed information on new high energy Indox V. Use this coupon to request your copy. Ask for Bulletin* ***16-C3.***

THE INDIANA STEEL PRODUCTS COMPANY • VALPARAISO, INDIANA

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16-C3

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For quickest service in solenoid valves, write for Skinner's Nationwide Stock List

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For complete information on Skinner's line of exceptionally long-life 2-, 3- and 4-way valves, write us or contact a Skinner representative. Write Dept. 453.

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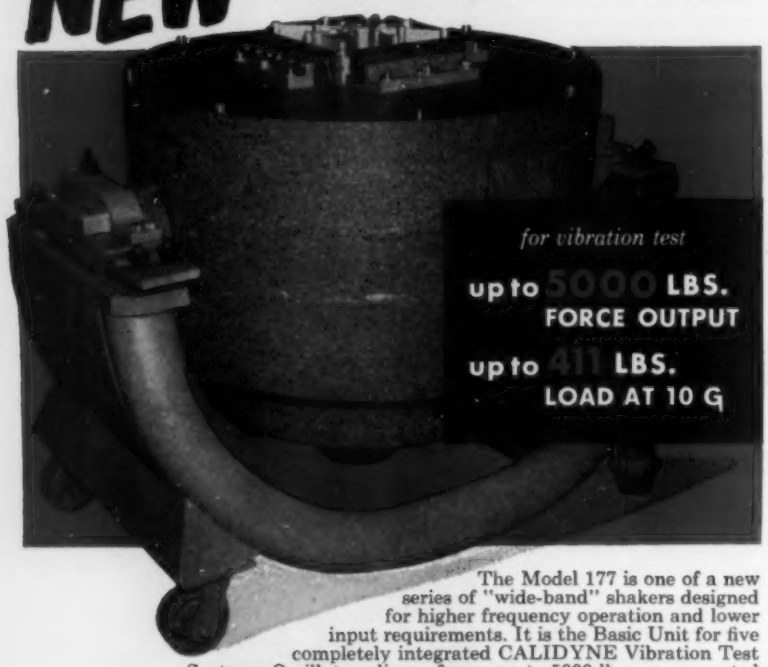
NEW CALIDYNE 177 SHAKER SYSTEMS



The Model 177 is one of a new series of "wide-band" shakers designed for higher frequency operation and lower input requirements. It is the Basic Unit for five completely integrated CALIDYNE Vibration Test Systems. Oscillatory linear forces up to 5000 lbs. are generated and precisely controlled over wide ranges for vibration research and test of products up to 411 lbs. maximum load. Any of these five Vibration Test Systems using this New Model CALIDYNE 177 Shaker will enable you to:

1. Discover effects of "brute force" shaking on your assemblies and determine their ability to withstand vibrations far beyond those of normal operation.
2. Provide factual vibration data essential in determining mode shape, frequency and damping characteristics.
3. Determine results of fatigue testing at extremely high stresses and deflections.

CALIDYNE VIBRATION TEST SYSTEMS USING NEW MODEL 177 SHAKER

System Number		Type of Vibration	Force Output	Power Supply	Frequency Range	Maximum Load	
						10 g.	20 g.
1	177/80	Sinusoidal	3500 lbs.	Electronic	5-2500 cps.	261 lbs.	86 lbs.
2	177/180	Sinusoidal	5000 lbs.	Rotary	5-2000 cps.	411 lbs.	161 lbs.
3	177/186	Sinusoidal	5000 lbs.	Electronic	5-2500 cps.	411 lbs.	161 lbs.
4	177/190	Random or Sinusoidal†	5000 lbs.	Electronic	5-2500 cps.	411 lbs.	161 lbs.
5	177/190	Random†	5000 lbs.	Electronic	5-2500 cps.	411 lbs.	161 lbs.

†*This system will perform with Random, Sinusoidal, Tape or Mixed Inputs.*

A separate Bulletin 17700 details the specifications, performance data, basic components and accessories of the new Model 177 CALIDYNE Shaker and its five Shaker Systems. For engineering counsel in applying Controlled Vibration to your research and testing, call us here at CALIDYNE — WInchester (Boston) 6-3810.

See us at I.R.E. Booth 3222-24

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CANADA

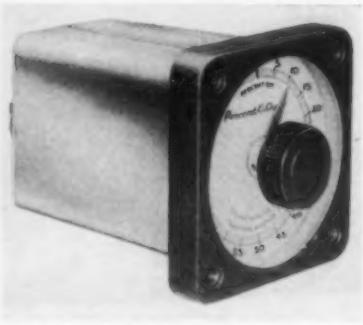
Measurement Engineering Ltd. Arnprior, Ont. (Phone 400) Burlington, Ont. (Nelson 4-5686)

EXPORT

Rocke International Corp. 13 East 40th Street, N. Y. 16, N. Y. (Murray Hill 9-0200)

Power interruptions during or after a timing cycle will result in automatic reset. Globe Industries, Inc., 1784 Stanley Ave., Dayton 4, Ohio.

For more information—
Circle 61, inside back cover



Adjustable Interval Timer

This timer is to be used as an alternate for rheostats and other variable voltage equipment. Loads up to 25 amp at 150 v, 60 cps may be handled without auxiliary equipment.

This unit closes a contact for an adjustable interval in a fixed time cycle with repeat accuracies less than 0.10 per cent. Standard time cycles from 15 sec to 8 hr. Measurements are $3\frac{5}{8}$ x $3\frac{5}{8}$ x $5\frac{3}{4}$ in. deep. Hagen Mfg. Co., 202-20 St., Moline, Ill.

For more information—
Circle 62, inside back cover

Miniature Aluminum Connectors

Contacts are Size 20, gold plated, with machine-closed entry sockets. There is a choice of quick-disconnect coupling between a modified double stub thread, or three-point bayonet lock. Provisions are available for

(Continued on page 257)

(Advertisement)

VOL. 2–NO. 1

NEWS OF MATERIALS THAT ARE IMPROVING TODAY'S PRODUCTS

THE NATIONAL SCENE

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PUBLISHED BY NATIONAL VULCANIZED FIBRE CO., MANUFACTURERS OF:

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A leader in the industrial design field for over 25 years, Donald Deskey is founder and senior partner of Donald Deskey Associates. Among the many well-known companies who have employed the Deskey services are: Bigelow-Sanford, Brunswick-Balke-Collender, Proctor & Gamble, Sinclair Oil and Westinghouse. Mr. Deskey is credited with being the first designer to introduce tube steel furniture into the U.S. on a mass production basis. Weldtex®, a striated plywood, was another of his developments.

A DESIGNER LOOKS AT MATERIALS

by Donald Deskey

The job of the designer has always been to create leadership through innovation. More often than not, however, he has been too closely associated with the drawing board—with applying a superficial "face-lifting" to the final product design.

Today's volume production-marketing concept has brought the designer's growing responsibilities into clear focus. In one sense, he has become the fulcrum balancing *efficient production* and *successful marketing*. And his decisions reach from the basic formulation of new product planning, through design and production, to many aspects of merchandising.

Prominent among his decisions, which affect almost every phase of bringing a new product to the market place, is the matter of material selection.

Selecting materials today is more complex than it ever has been for the simple reason that the *choice of materials*—in a variety of grades—is greater. If this problem is complex today, it will grow more so. In a climate where some new material is brought forth almost every day, there is a natural tendency to lean in the direction of this "newness" and the promise of unusual and exciting properties. Obviously, this is a healthy tendency, for with each new material it usually follows that some design obstacle is removed.

Yet it is in this very area of material exploration and evaluation that the designer must exercise his full experience and his appreciation of the production problems involved in working a new material, or the unforeseen difficulties in selling a product made of a new material. An example of the latter, still vivid, is the general apathy on the part of the customer to all plastics immediately after World War II. Today, these materials have rightfully gained full consumer acceptance in a multitude of products. This has been due largely to more intelligent application of materials.

Often, the solution to a materials selection problem can be found without excessive trial, expense and delay if the designer's approach is one of: "What *new* refinement can be achieved with this old material?" rather than, "What can be done with this new material?". Here's a recent example . . .

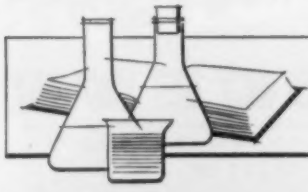
Vulcanized Fibre is undergoing considerable re-examination by a number of designers and manufacturers. This material is a chemically pure converted cotton cellulose and has been available for over 80 years. For a material that has been around so long, its general properties are quite amazing. It is extremely tough in all sizes and forms, and almost horn-like in thick sections. It weighs only half as much as aluminum and is .9 as strong. Fibre can be colored in manufacture; painted or vinyl-sprayed without pre-treatment or finishing; cold-embossed; and will take a high polish. It can be formed and deep-drawn; is easily machined and fabricated. This smooth material can be laminated, or combined with other materials, and has a natural, somewhat "warmer" feel to it than most synthetic materials.

Current explorations of Vulcanized Fibre indicate considerable promise in structural applications far beyond the materials-handling containers, wastebaskets and trunks in which the material has been extensively used.

Certainly new materials offer an exciting highway to new horizons in design. But in practical day-to-day solutions, the possibilities with known basic materials at hand are unlimited—if we choose to examine their potentials.

NYLON JOINS NATIONAL MATERIALS FAMILY

in extruded rods, ¼ through 2-inch diameter in 3 and 6-ft. lengths, and precision fabricated parts. The addition of nylon now offers the designer more than 100 grades of National materials from which to select. It's industry's broadest line. Circle item D on back page for more information.



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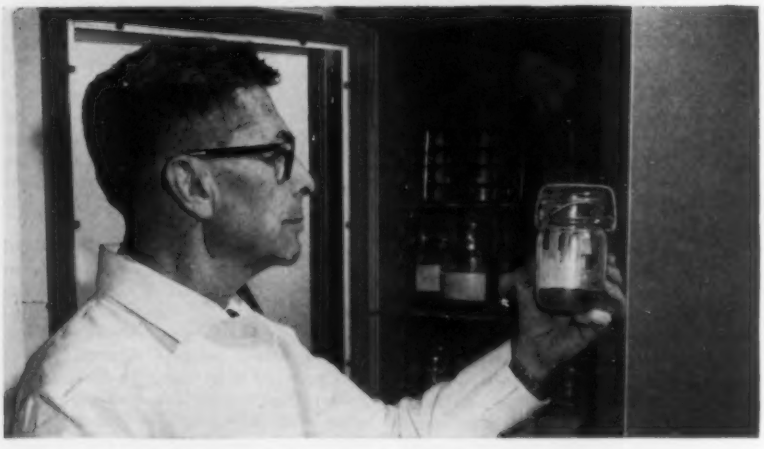


Out of National's Research and Development Laboratories come material property variations that permit an ever-broadening range of new applications.

Case in Point: A leading refrigerator manufacturer found that Vulcanized Fibre had the desired properties for a refrigerator door latch—with one exception. Fibre—in its natural state—could not pass the stringent test for fungus resistance.

Solving the Problem: National duplicated the manufacturer's testing procedure and tested all known fungus-proof coatings. All proved unsuitable. Protective coatings cracked during the punching operation—exposing hair-like lines in which fungus could grow. National had to find a fungicide that was water-soluble to penetrate the fibre, that was not toxic to humans, that was odorless and tasteless, yet would withstand the onslaught of the most destructive fungi.

Most of the fungicides tested proved toxic or gave off odor. But after more than a year of continuous testing, a fungicide was developed that met all conditions. National has supplied fungus-proof Vulcanized Fibre door latches to this customer ever since.

For this application, Vulcanized Fibre must pass these tests:

Fungus Test: Pieces of .020 black fibre are suspended in sterilized jars which contain a nutrient in which fungi will grow. Fibre and the nutrient medium are inoculated with spores of aspergillus flavus, aspergillus niger and chaelomiun globusum. After 30 days in incubator—humid atmosphere at 84 to 90°F temperature—the jars are opened and examined for any evidence of fungus growth on the fibre.

Stain Test: Black fibre pieces are soaked with tap water for one hour. Then laid on white Dulux coated metal and put under 25 psi pressure for seven days at room temperature. When removed, the Dulux coating is tested for stain.

Odor Test: Unsalted butter, distilled water and the fibre samples are refrigerated in a closed jar at 45°F for 16 hours. When removed, they are tested for odor and taste.

In addition to meeting all the above tests, National Vulcanized Fibre must, and does, meet the severe physical tests for this door-latch application to complete customer satisfaction.

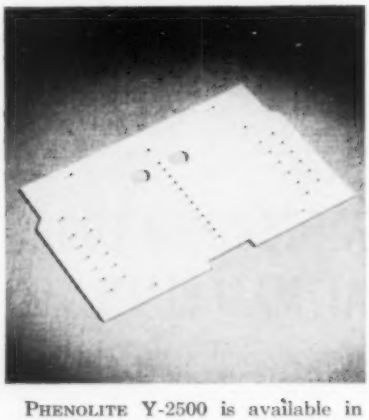
New Paper Base Laminate Resists Arcing and Flame

A new paper base laminate with superior arc and flame resistance is available in production quantities from National.

Identified as PHENOLITE Y-2500, it is bonded with a modified phenolic resin that gives fire resistance qualities for superior service in electrical and electronic applications.

While its general properties correspond to NEMA Grade XX, National's new PHENOLITE Y-2500 also provides arc resistance of 100 seconds. The new material punches and shaves better than any melamine paper base laminates presently used for arc-resistant applications. As a self-extinguishing laminate, it passes the standard Underwriters Laboratory flame test.

Recommended for use where arc and flame resistance are of primary importance and where economy is a factor, PHENOLITE Y-2500 laminate is particularly suited for such applications as: arc deflectors, circuit breaker components, electrical switches and other interrupting devices.



PHENOLITE Y-2500 is available in sheet sizes of 39 by 47 and 39 by 39 in. and in thickness from .015 to 1.0 in. It comes in a standard semi-gloss and a special dull finish in either natural (light brown) or red.

For more information on PHENOLITE Y-2500 paper base laminate, circle item A in the literature section on the back page.

NATIONAL COMPARATOR CHART helps designers select one best material

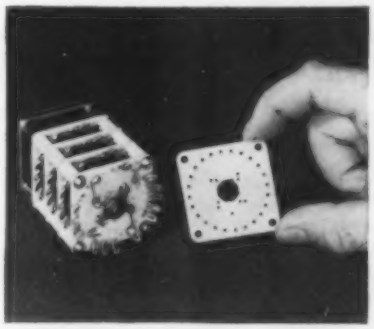
Selecting the best material for a new part is easy when you use the new National Basic Materials Comparator Chart. This chart rates 34 materials for 23 properties, including cost. All you do is list your material specifications and check them *in order of importance* against the comparator chart. Circle the ratings that qualify.

Typical Problem: Assume that you want the best switch-plate material for a new line of precision rotary switches. Your specifications are: (1) Electrical stability under humid conditions, (2) Low dielectric loss, (3) Low moisture absorption, (4) Heat resistance, (5) Insulation resistance and (6) A combination of impact strength, dimensional stability and acid and alkali resistance.

Easy to Use: First, check your prime requirement—electrical stability—against the electrical stability ratings in the chart. Circle all 'E' ratings. Seven grades qualify. Second, circle those of these seven grades that score best for low dielectric loss. Since six score 'excellent', drop the grade that scores only 'good'.

For the third requirement—low moisture absorption—all six remaining grades pass with 'excellent' ratings.

When checking and circling the fourth specification—heat resistance—the grades are reduced to two. The fifth material requirement—insulation resistance—narrows the field to Grade G-7-830. Rapidly checking Grade G-7-830 with the remaining requirements, we find it passes all with high ratings. You now have chosen the best material for your switch plate.



Grade G-7-830 PHENOLITE, selected through use of Comparator Chart, is made into switch plates for precision rotary switches.

For your free copy of 'National Basic Materials Comparator Chart', circle Item C in the literature section on the next page.

NATIONAL BASIC MATERIALS COMPARATOR CHART

● PHENOLITE LAMINATED PLASTIC

▲ NATIONAL VULCANIZED FIBRE

	PROPERTIES																																				
ELECTRICAL	Dielectric Strength—Perpendicular to laminations (500 volt per sec rise to 1/16" = G)	E	E	G	G	E	E	G	G	G	G	P	P	G	P	G	F	P	P	G	P	F	E	G	F	F	F	E	F	F	G	F	F	F	F
	Dielectric Strength—Parallel to laminations (50 KV = G)	P	P	G	P	G	E	E	E	E	F	P	P	G	P	G	P	P	P	E	P	P	F	F	G	G	G	G	G	G	G	G	G	G	G	G
	Dielectric Losses	P	P	F	P	G	G	E	E	E	G	P	P	F	P	F	P	P	P	G	P	G	G	G	E	E	G	E	F	G	G	G	P	P	P	P
	Insulation resistance	P	P	F	P	F	G	G	E	E	F	P	P	P	P	P	P	P	P	E	P	P	F	F	F	G	P	E	P	P	P	P	P	P	P	P
	Arc resistance	P	P	P	P	P	P	P	P	P	G	P	G	P	P	P	P	P	P	P	P	P	P	E	E	E	E	E	G	G	P	E	E	E	E	E
	Electrical Stability—Humid Conditions	P	P	F	F	G	G	E	E	E	G	P	P	G	P	G	F	P	P	E	P	F	F	G	E	E	G	E	G	F	G	G	P	P	P	P
MECHANICAL	Tensile Strength (15,000 psi = G)	G	G	F	P	G	F	F	G	G	G	F	F	F	F	F	F	F	E	P	G	F	E	E	G	E	G	E	G	G	G	G	P	F	F	F
	Flexural Strength (20,000 psi = G)	G	G	F	P	F	F	F	G	G	F	G	G	G	G	G	G	G	F	G	E	E	E	G	E	G	E	G	G	G	G	G	P	F	F	P
	Compressive Strength (30,000 psi = G)	G	G	F	F	G	F	G	F	F	G	G	E	G	G	G	E	E	E	P	E	E	E	E	E	E	E	E	E	E	E	E	G	E	G	G
	Impact Strength (1.0 ft. lbs. = G)	G	G	F	F	F	F	F	F	F	F	G	G	G	G	G	G	G	G	G	G	E	E	E	E	E	E	E	E	E	E	E	G	G	G	E
	Bond Strength	G	G	F	P	G	F	G	F	F	G	E	E	E	E	E	F	E	G	G	P	G	G	E	G	P	E	E	G	G	G	G	G	G	G	G
PHYSICAL	Water Absorption	P	P	F	F	G	G	E	E	E	G	F	F	G	F	G	F	P	F	E	F	F	F	G	E	E	F	E	G	G	G	G	P	P	P	P
	Dimensional Stability—Humid Conditions	P	P	F	F	G	G	E	E	E	G	F	F	G	F	G	F	P	F	E	F	F	F	G	E	E	F	E	G	G	G	G	P	P	P	P
	Heat Resistance	F	F	F	P	G	F	G	F	F	G	F	F	G	F	G	G	G	G	P	F	G	G	G	E	E	G	G	G	G	G	G	P	P	P	P
CHEMICAL	Acid Resistance	F	F	F	F	F	F	G	G	G	F	F	F	G	F	G	F	F	F	G	F	F	F	P	G	G	F	G	G	G	G	G	P	P	P	P
	Alkali Resistance	P	P	P	P	P	P	P	P	P	F	P	G	G	P	F	P	P	P	F	P	P	P	G	G	G	G	G	F	F	F	F	F	F	F	F
	Organic Solvent Resistance	F	P	P	P	G	F	E	F	F	G	G	G	G	G	G	G	G	G	G	G	G	G	G	P	P	G	G	G	G	G	G	G	E	E	E
FABRICATION	Machining Qualities	F	F	F	F	G	G	G	G	G	F	E	F	E	E	E	F	F	F	E	G	P	P	P	P	P	P	P	P	P	P	P	E	E	E	E
	Punching Qualities	F	F	E	E	F	G	P	G	G	F	G	P	F	E	F	F	F	F	E	G	F	F	F	F	F	F	G	F	F	F	F	E	E	E	E
GENERAL	Base Material	Kraft Paper	Paper	Paper	Paper	Paper	Paper	Paper	Paper	Paper	Paper	Cotton Fabric	Cotton Fabric	Cotton Fabric	Cotton Fabric	Cotton Fabric	Cotton Fabric	Asbestos Paper	Asbestos Fabric	Asbestos Mat	Rayon Cloth	Cotton Mat	Glass Cotton Fabric	Cord Glass Fabric	Cord Glass Fabric	Glass Cotton Fabric	Cord Glass Fabric	Glass Mat	Cord Glass Cloth	Glass Mat	Glass Mat	Glass Mat	Glass Mat	Cotton Paper	Cotton Paper	Cotton Paper
	Type of Resin	Phenolic	Phenolic	Phenolic	Phenolic	Phenolic	Phenolic	Phenolic	Phenolic	Phenolic	Modified Phenolic	Phenolic	Melamine	Phenolic	Phenolic	Phenolic	Phenolic	Phenolic	Phenolic	Phenolic	Phenolic	Phenolic	Phenolic	Melamine	Silicone	Silicone	Melamine	Epoxy	Polyester	Polyester	Polyester	Polyester	—	—	—
	AIEE Insulation Class	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	E	B	B	H	H	B	B	B	B	B	B	B	O	O	O
	Comparative Price*	.7	.5	.8	.8	1.0	1.0	1.1	1.2	1.0	1.2	1.4	1.6	1.4	1.7	1.7	1.1	2.7	2	3.1	1.4	2.0	2.1	2.4	6.2	6.7	1.6	2.7	1.4	8	1.6	1.6	A	A	A
	Catalog Page Reference	35	35	35	35	22	23	23	24	25	25	26	26	27	28	28	29	28	28	32	32	30	30	30	30	31	31	31	33	33	33	33	12	12	12

*COMPARATIVE PRICES are based on the price of Grade XX as an arbitrary scale of 1.0 and are quoted on 1/16" thickness at maximum quantity discount. One only at a point were price volume quantity, thickness, and tolerance required.

(NOTE: This chart based on average test values on 1/16" thick sheet material.

CODE: E—Excellent G—Good F—Fair P—Poor

DESIGNERS ARE USING

Rectifier enclosures are machined from natural XXX-36 square PHENOLITE tubing. Superior dielectric properties (dielectric constant—10^6 cycles—5.3) and physical strength (compressive strength—22,000 psi) are the prime reasons for this application.

Extreme strength in relation to light weight recommends natural XN-152 PHENOLITE for use in mountings for aviation instruments.

Peerless Electrical Insulation Grade of National Vulcanized Fibre is formed into coil insulators for small electric windshield wiper motors. This application utilizes Peerless Insulation's superior electrical characteristics, ability to be easily formed and reasonable cost.

Strips of Commercial Grade Vulcanized Fibre are punched into type holders for automatic check imprinters. For this application, Vulcanized Fibre met the following specifications: (1) tolerance within ±.002-in., (2) flexibility to permit bending on the printing head, (3) toughness to withstand repeated printing impressions, and (4) relatively low cost.

Superior electrical insulation qualities and low cost are the reasons why Peerless Insulation is formed into the auto rheostat insulator shown here.

NATIONAL
VULCANIZED FIBRE CO.
WILMINGTON 99, DELAWARE
In Canada
NATIONAL FIBRE COMPANY OF CANADA, LTD., Toronto 3, Ontario

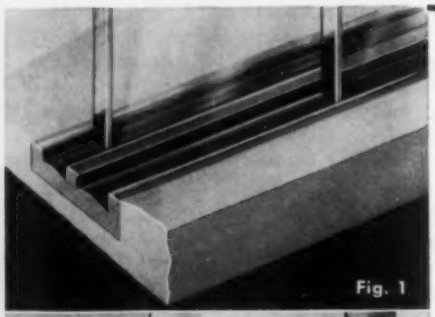


Fig. 1

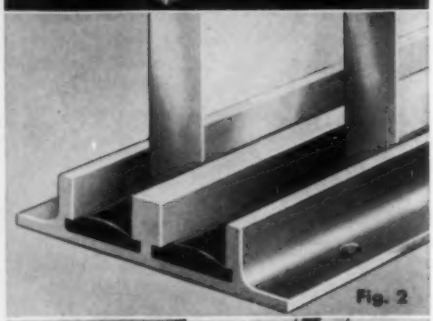


Fig. 2

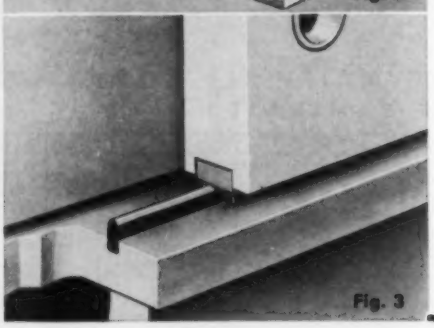


Fig. 3

FIBRE:

A SMOOTH SOLUTION

Mr. Hayes Scott, President, Engineered Products Company, states, "We have yet to find a material that comes close to the quality of National Vulcanized Fibre for our glides and tracks." Fibre's hardness, smoothness, resistance to wear and low friction coefficient make this application a natural.

Fig. 1

Solid fibre tracks for by-passing glass doors.

Fig. 2

Machined fibre sliding surface inserts in aluminum tracks.

Fig. 3

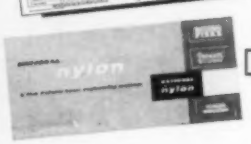
For sliding doors, a fibre guide rides on a fibre blade.

NATIONAL VULCANIZED FIBRE CO., Dept. H-3, Wilmington 99, Del.
Please send me literature checked below.
☐ **I would like to receive THE NATIONAL SCENE regularly.**

☐ **A. Materials Catalog, 16p.**

☐ **C. Comparator Chart, 4p.**

☐ **B. Fabricating Booklet, 8p.**



☐ **D. Nylon Data Folder, 6 p.**

NAME ..... TITLE .....

COMPANY .....

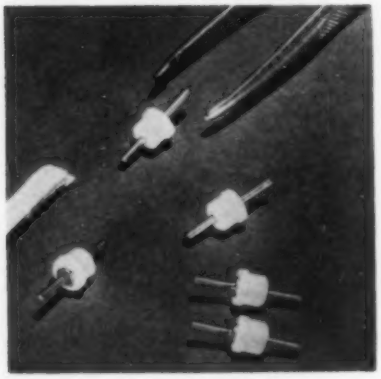
ADDRESS .....

CITY ..... ZONE ..... STATE .....

grommet sealing, potting, cable sealing, conduit applications.

These connectors are manufactured in a wide variety of shell styles and insert arrangements. Shell sizes range from $\frac{3}{8}$ to $1\frac{3}{8}$ in. ID and incorporate from 1 to 55 contacts. Avnet Eastern Sales, 36 N. Moore St., New York 13, N. Y.

For more information—
Circle 63, inside back cover



Subminiature Terminals

These are Teflon-insulated, stand-off and feed-through terminals. Capacitances range from 0.35 to 0.75 with "flash-over" points of better than 500 v a-c. Service ratings include 60 cps to 30,000 mc frequencies, temperature range of –450 to 500 F. Sizes range from 0.148 to 0.218 in. dia, with 0.040 in. dia pins. Tri-Point Plastics, Inc., 175-177 I.U. Willets Road, Albertson, N.Y.

For more information—
Circle 64, inside back cover

Counter Adds and Subtracts

To do subtraction with this electronic counter, the operator enters the minuend, complements, enters the subtrahend, and complements a second time. The resulting difference is displayed as an uncoded decimal. The device can accept digital information serially as a unitary pulse train, or in parallel in binary coded decimal form. Unitary and binary coded decimal electrical outputs permit the calculating of all kinds of arithmetical problems and provide a means of control for industrial processes. The readout can be non-destructive of the

(Continued on page 260)

. . . check with Milford Engineers!

Riveting raises *special* problems and requires *special* skills. You must have the right type and size rivet for each application, or the results can be costly . . . in production and in profits. When you're faced with a riveting problem, let Milford engineers lend a hand before designs are fixed!

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. . . to take full advantage of automatic assembly
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MILFORD, CONNECTICUT • HATBORO, PENNSYLVANIA
ELYRIA, OHIO • AURORA, ILLINOIS • NORWALK, CALIF.

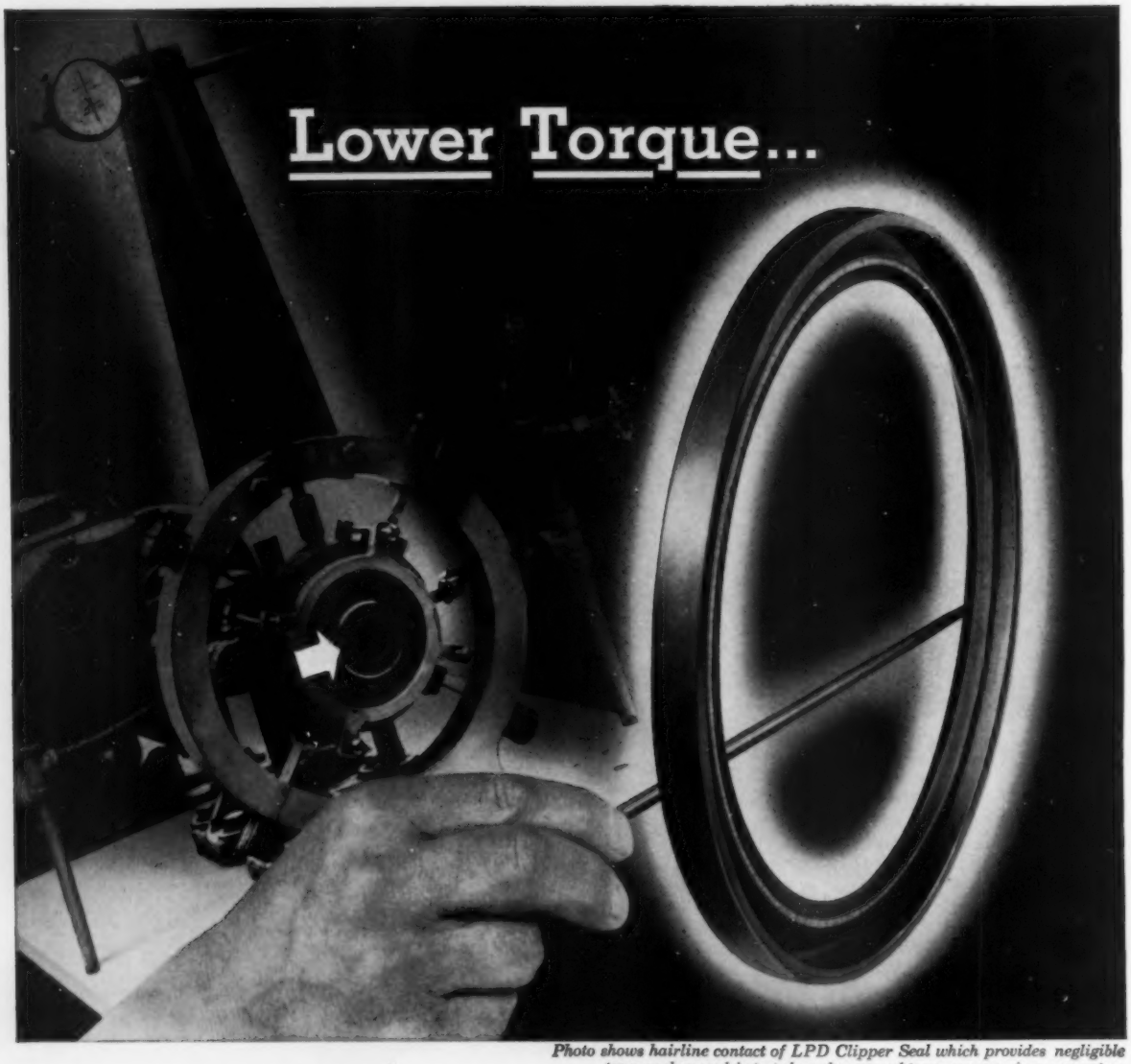


Photo shows hairline contact of LPD Clipper Seal which provides negligible torque when seal is tested on dry run of torque measuring apparatus.

How J-M Clipper Oil Seals cut shaft drag

line contact minimizes interference... provides cooler running

Take a close look at the lip of a Johns-Manville Clipper Seal. You'll see how the bearing area has been narrowed down to a sharp line contact. That's why you get less power consumption and lower operating temperatures when you use Clipper Seals to seal in lubricant, seal out dirt.

What's more, this line contact requires less lubrication and yet receives far more in proportion to its surface than any other design. It all adds up to greater sealing efficiency and longer seal life for Clipper Seal users. This exclusive line contact feature is provided on all LPD Clipper Seal designs which are adaptable to most applications.

Lower torque is only one of many advantages you get with J-M Clipper Seals. Precision moulded from a variety of corrosion-resistant compounds specially developed for each service, they provide maximum sealing ability, long life, wide adaptability and easy installation. For more information on the complete line of Clipper Seals, write for new 28-page illustrated brochure PK-71A. Address Johns-Manville, Box 60, New York 16, N. Y. In Canada: 565 Lakeshore Road East, Port Credit, Ontario.

JOHNS-MANVILLE JM PRODUCTS

Johns-Manville CLIPPER SEALS

E.D.O.S.

... A. O. Smith's proven method for fabricating aircraft that will

smash
the thermal barrier

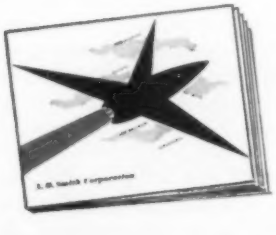
✳ E. D. O. S. means Engineered Designs for Optimum Structures . . . offers significant savings in fabrication of hard, heat-resistant alloys.

BACK when airframe construction first switched from wood and fabric to light metals — the thin alloy skins were actually sewn together with piano wire. Manufacturing methods had not kept pace with materials development.

Today, with supersonic aircraft nudging the thermal barrier, there's another big switch underway . . . a change to heat-resistant, high-strength alloys (steel, titanium, stainless).

This time, however, there's no need to compromise with light metal methods in hard metal fabrication. No need for extensive, time-consuming machining...no need to turn costly alloys into scrap.

The answer is A. O. Smith's E.D.O.S. — redistribution of metal for maximum usefulness. Proved in the manufacture of jet engine parts and other aircraft components — the method consists of precision forging, contour rolling, flash and fusion welding. It's made to order for tough metals . . . produces a lighter, stronger product at lower cost than any other existing process.



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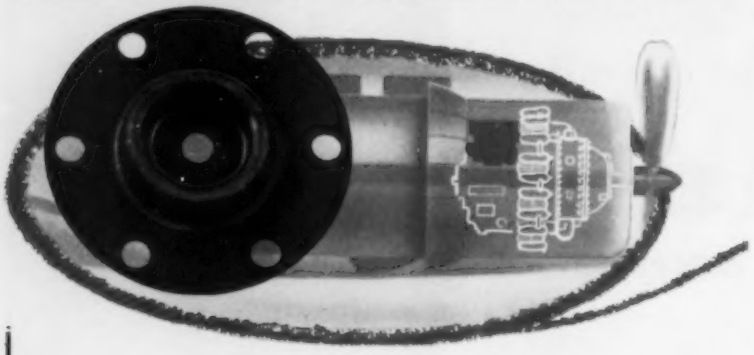
International Division: Milwaukee 1, Wisconsin

THE SHAPE OF THINGS IN MOLDED RUBBER

MOLDED RUBBER & NYLON FABRIC INCREASES LIFE OF CARBURETOR DIAPHRAGM



APPLICATION:
Aircraft carburetor diaphragm molded for a nationally known aviation firm.

PROBLEM:
Nylon from customer's approved suppliers would not mold, therefore, holding up further development on diaphragm.

SOLUTION:
Acushnet chemists tested many types of nylon fabrics and in co-operation with the nylon supplier, used the results as a guide for a new fabric specification. New techniques were developed by the Acushnet laboratories to prevent pleating of the nylon. A special Acushnet compound molded to one side of the nylon proved successful in resisting the specified iso-octane and aromatic fuels. All dimensions were held to ± .003" without increasing the rejection rate. To further insure its life span, the bolt flange was molded of double coated neoprene on cotton which provided for greater strength and tear resistance.

Let Acushnet be responsible for producing your next molded rubber diaphragm. The complete facilities for creating special compounds and working with new fabrics assure precision diaphragms of all types and sizes.

Send for Acushnet "Rubber Data Handbook."

What's Your Shape?

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ACUSHNET PROCESS COMPANY
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Address all communications to 768 Belleville Ave., New Bedford, Mass.

stored value and the latter is also visually displayed in uncoded decimal. Victor Adding Machine Co., 3900 N. Rockwell St., Chicago 18, Ill.

For more information—
Circle 65, inside back cover

Digital Turns-Counting Dial

This ten-turn dial gives numerical readings in full turns, tenths and hundredths. The unit has a reading resolution of 0.50 per cent. It is equipped with a friction lock which can be engaged without disturbing the dial setting. Helipot Corp., Newport Beach, Calif.

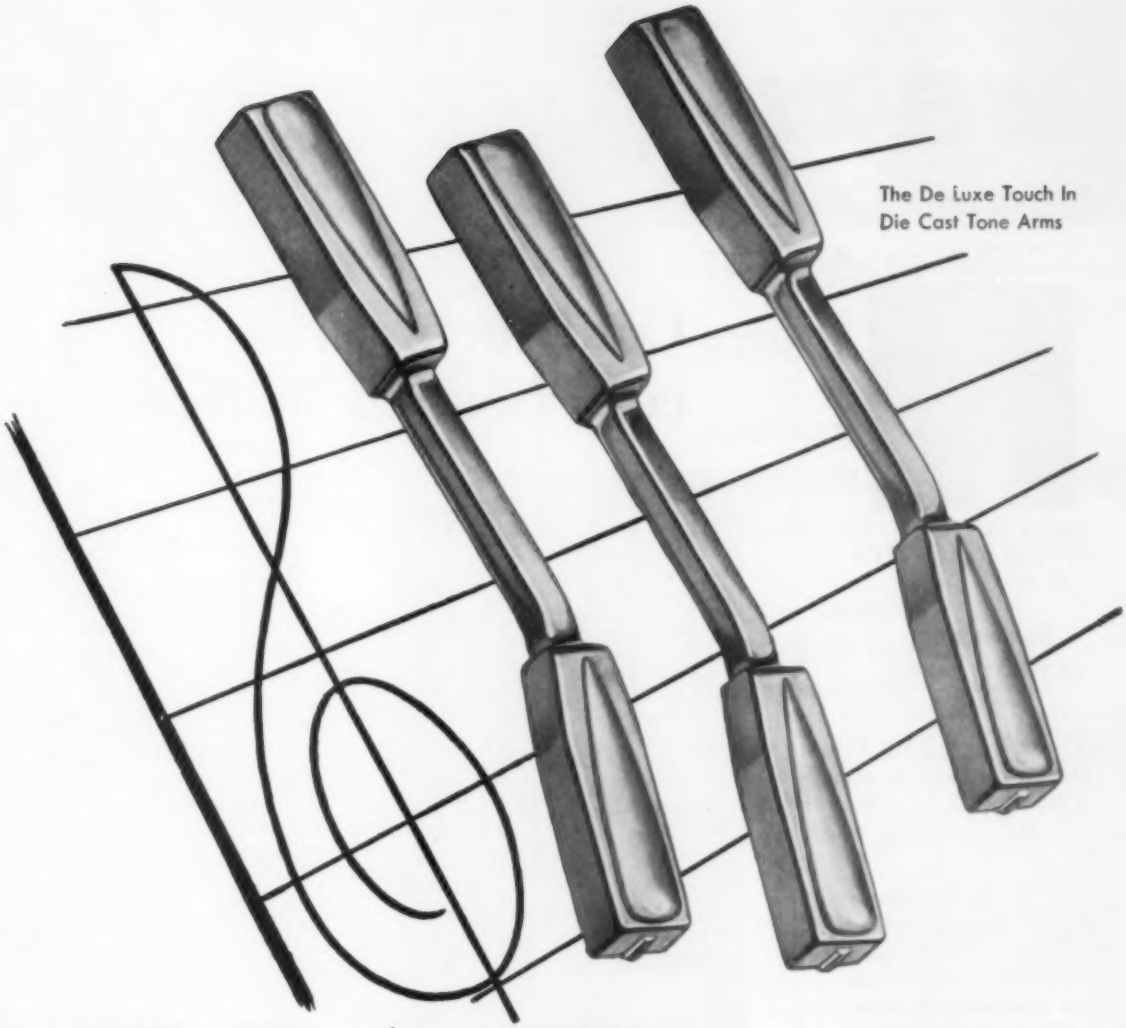
For more information—
Circle 66, inside back cover

Differential Pressure Pickup

A pickup in which a dry strain-gage element is isolated from the pressurized fluid is suitable where differential measuring or pressure control devices are used in conjunction with corrosive or conductive fluids. Pressure differences are transmitted from a single diaphragm through a mechanical linkage.

Models are available for sensing pressure differentials from ±½ psi to ±1000 psi at line pressures up to

(Continued on page 264)



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Die Cast Tone Arms

The De Luxe Touch—

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Technical-ities
By John S. Davey

Tighten bolts to yield strength?

Actually, it is safer to "overtighten" than to undertighten. The following explains why.

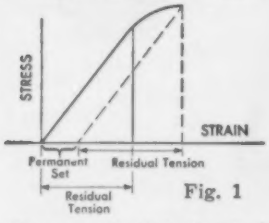


Fig. 1

Up to yield point, the strain in a bolt is proportional to stress. *Beyond* the elastic limit, the bolt goes into its "plastic range". Some permanent stretch takes place. (Fig. 1). Yet while the bolt will not return to original length, note that *residual tension* is fully maintained. And remember, it's *this* force that keeps a bolt tight, determines joint strength.

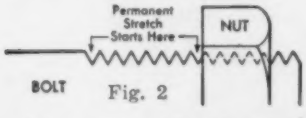
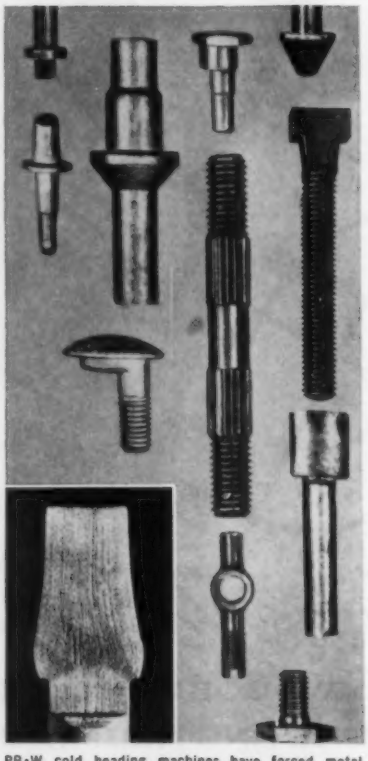


Fig. 2

The permanent set starts at section with highest unit stress —which is at the unengaged threads (Fig. 2). Ultimately, this throws thread pitch off and nut locks, subjecting bolt to torsion (rather than further tightening). This force disappears with wrench-removal. Thus, a bolt can even be torqued well into its plastic range if it won't be reused or need adjustment.

Cold facts on cold headed fasteners



RB&W cold heading machines have forced metal to flow into this typical variety of shaped pieces—just a handful of thousands of different cold headed shapes produced by RB&W to specification. The upset can be at any point, and the shape need not be symmetrical. The continuous, symmetrical flow lines (inset) make metal stronger.

NO ATTEMPT to simplify, improve or economize on fastening is complete without a good look at your screw machine parts, forgings, and certain assemblies that can be reduced to one piece.

You would be surprised at what an expert can produce on cold headers with complete uniformity. Cold heading produces in one piece parts that would otherwise be two or more.

BETTER FLOW LINES

Just as it does with standard fasteners, cold heading makes possible a higher quality, stronger product at high speed and low cost. Properly done, the operation upsets metal along its own axis in continuous flow lines without folds. Stress patterns are better. Fasteners and parts gain greater shear, impact and fatigue strength.

Long a specialist in cold headed fasteners, RB&W offers its experience to designers and production men who want to know whether cold heading is feasible for specific mechanical shapes. If it proves to be so, RB&W facilities can handle your volume needs. Contact Russell, Burdsall & Ward Bolt and Nut Company, Port Chester, New York.

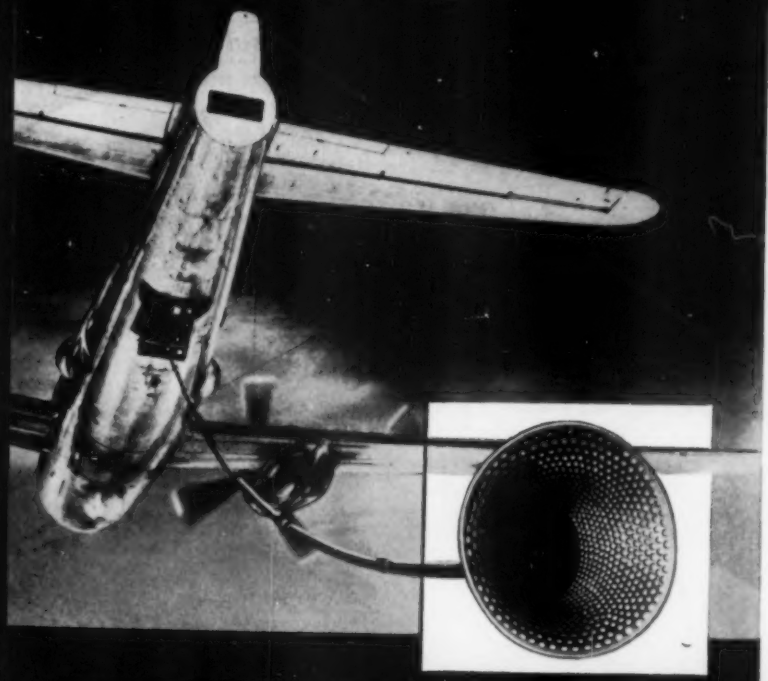
Plants at: Port Chester, N. Y.; Coraopolis, Pa.; Rock Falls, Ill.; Los Angeles, Calif. Additional sales offices at: Ardmore (Phila.), Pa.; Pittsburgh; Detroit; Chicago; Dallas; San Francisco.

Spin-Lock® Screws solve assembly problem

The designer specified countersunk-head screws to be used in a particular casting. The production man had to stake these in to anchor them. But this meant extra operation, made screw removal damaging and difficult.

The answer was found in Spin-Lock screws. These have hardened "ratchet-action" teeth that bite in when tightened, take 20% more torque to loosen than to tighten, can be reused. Send for Bulletin.

Spin-Lock "tooth" about to bite in. Head meets seat when fully tightened.



FLYING GAS STATION!

Drogues for refueling aircraft in flight show how Araldite Epoxy-glass cloth laminates combine high strength/weight ratios with excellent chemical resistance.

Hampden Brass & Aluminum Co.
Flight Refueling Co., Inc.

ARMOR FOR BOATS!

Here an Araldite Epoxy formulation is used with glass cloth for the armor-plating of small boats. The same combination can be used for the rapid, inexpensive repair of splits and gouges in boat hulls.

Cordo Chemical Corporation

from gas stations in the sky... to armor for small boats...

LAMINATING WITH ARALDITE® EPOXIES SPEEDS UP PRODUCTION.

EASILY PROTOTYPED... LOW COST MOLDS... FAST CURING!

Is your problem the production of prototypes for design approval? Is it mass production laminates . . . is it custom work? Whatever the problem, Araldite Epoxies may help you.

Their unique combination of extremely low shrinkage (from less than 0.5% to 2%), dimensional stability, rapid curing (in minutes with heat), and excellent adhesion, are providing answers daily to design and production needs.

Molds, too, can be made inexpensively from wood, plaster or metal.

Or if your interests are tooling, electrical, adhesives or coatings, it would pay you to investigate Araldite Epoxies.

Why not now? The coupon is for your convenience.

CIBA

"FIRST IN EPOXIES"

CIBA's Technical Services, including complete and up-to-date bulletins on the properties and uses of Araldite Epoxy Resins, are always available for the solution of your Epoxy problems. For full information, mail coupon or write . . .

CIBA produces *basic resins only*, to be formulated for intermediate and end uses.

CIBA COMPANY INC., Plastics Division
Kimberton, Pennsylvania

PE-3

Please send me full information on CIBA Epoxy Resins for

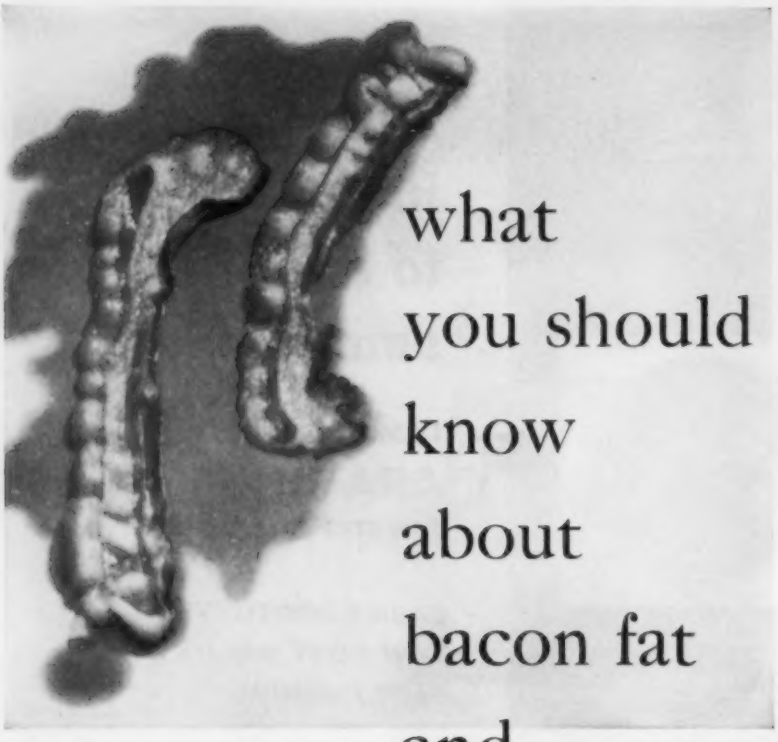
- ☐ Tooling
- ☐ Electrical
- ☐ Structural Laminates
- ☐ Hi-Strength Adhesives
- ☐ General
- ☐ Surface Coatings
- ☐ Plastic Body Solders

NAME _____

COMPANY _____ TITLE _____

ADDRESS _____

CITY _____ STATE _____



what you should know about bacon fat and Albanene®

Here's the buying information you should have to get the *best* value when you buy tracing paper.

1. **The usual way** of "transparentizing" tracing papers is with waxes or mineral oils—much the way bacon fat makes a paper towel transparent. Eventually, these oily fluids "leak" out—leaving the paper opaque and useless for reproductions.

   Result: Valuable drawings on ordinary tracing papers eventually become yellow or brittle—lose their reproduction qualities. And, these days, replacements often cost twice as much as the originals.

2. **The K & E way**—Albanene tracing paper is made transparent with an inert synthetic resin which is chemically stable . . . can't leak out—ever!

   Result: Albanene stays transparent . . . stays strong . . . protects every nickel you invest in time and talent working on it.

   Important: During manufacture, constant testing *guarantees* uniformity as well as pencil taking and erasing qualities. The very qualities that have made Albanene—America's best selling tracing paper.

Try Albanene Today . . . it's available in 3 weights and in rolls, sheets or pads. Try it now . . . it's the best value you can buy!

89 YEARS OF LEADERSHIP

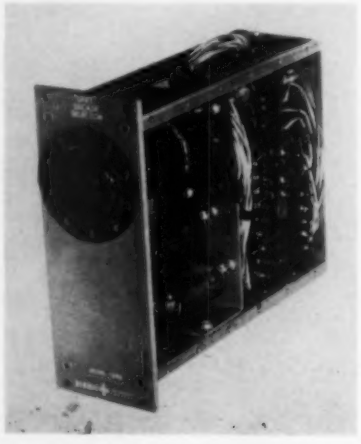
In equipment and materials for drafting, surveying, reproduction and optical tooling . . . in slide rules and measuring tapes.

K+E KEUFFEL & ESSER CO.

NEW YORK • HOBOKEN, N. J. • Detroit • Chicago • St. Louis • Dallas • San Francisco • Los Angeles
Seattle • Montreal

2000 psi. Temperature range is –65 F to 350 F. Dynamic Instrument Co., Inc., Cambridge, Mass.

For more information—
Circle 67, inside back cover



Plug-In Decade Counter

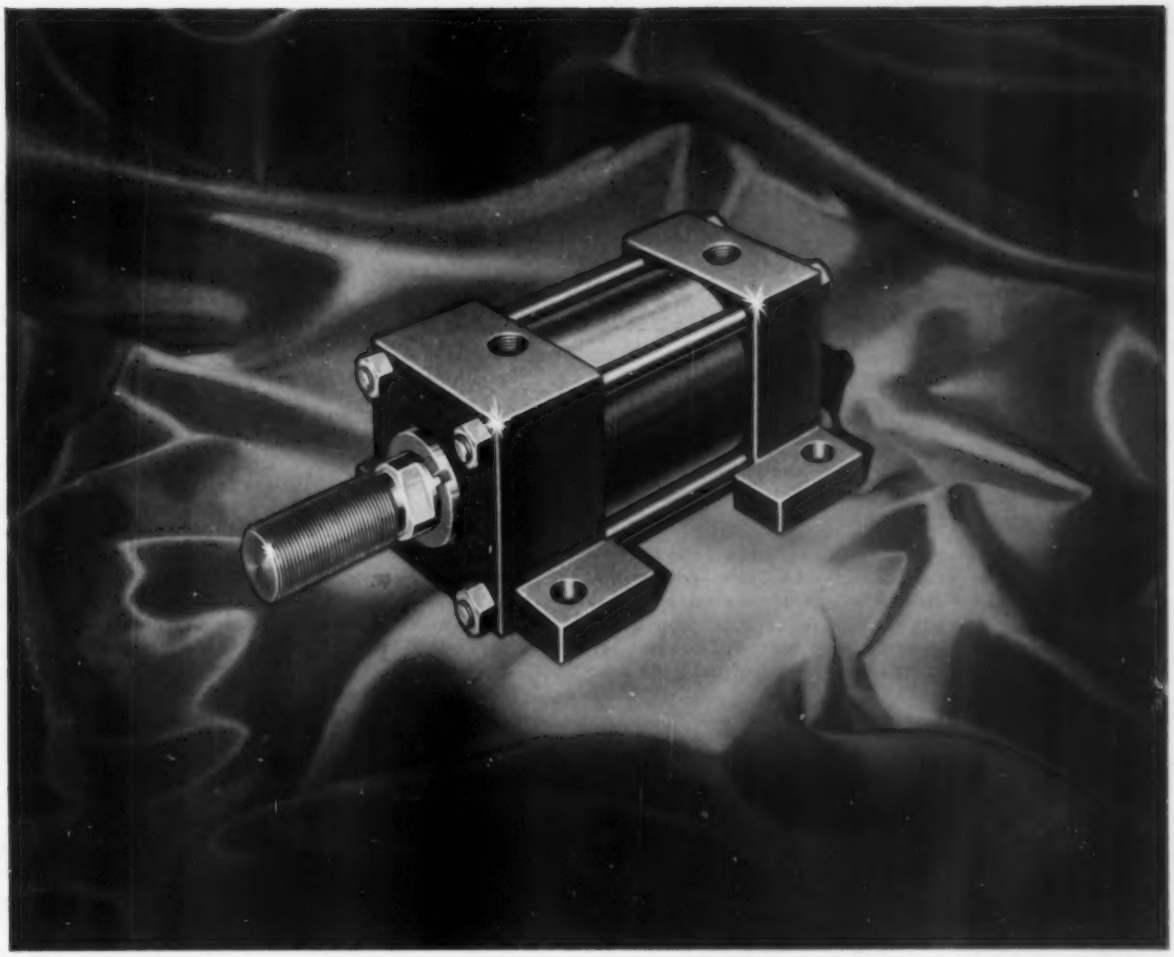
A decade-counting, ten-wire output strip for counting and readout applications has a maximum counting speed of 4 kc. Minimum input requirement is a 15 v positive pulse at least 100 microsec wide; output signal is a 30 v positive pulse. Output impedance is 100 k. Baird-Atomic, Inc., 33 University Road, Cambridge 38, Mass.

For more information—
Circle 68, inside back cover

Panel Indicator Light

A twin-lamp rectangular indicator light can carry abbreviations, words, or entire phrases on its 1⅛ x ⅞ in. plastic face. The face is back-lighted

(Continued on page 268)



Illustrated—Logan Super-Matic Cylinder Meets J.I.C. Standards

Look to Logan

the ultimate in hydraulic cylinder design

FREE SEND FOR THE "LOGAN CALCULATOR"

MEMBER: Natl. Mach. Tool Builders' Assn.; Natl. Fluid Power Assn.

LOGANSPORT MACHINE CO., INC.
812 CENTER AVENUE, LOGANSPORT, INDIANA

PLEASE SEND COPY OF CATALOG:

- ☐ 100-1 AIR CYLINDERS
- ☐ 100-2 MILL-TYPE AIR CYLS.
- ☐ 100-3 AIR-DRAULIC CYLS.
- ☐ 100-4 AIR VALVES
- ☐ 100-5 LOGANSQUARE CYLINDERS
- ☐ 100-5-1 ULTRAMATION CYLINDERS
- ☐ 51 PRESSES
- ☐ FACTS OF LIFE
- ☐ 62 SURE-FLOW PUMPS
- ☐ 200-1 HYD. POWER UNITS
- ☐ 200-2 ROTOCAST HYD. CYLINDERS
- ☐ 200-3 750 SERIES HYD. CYLINDERS
- ☐ 200-4 and 200-7 HYD. VALVES
- ☐ 200-6 SUPER-MATIC CYLS.
- ☐ 70-1 CHUCKS
- ☐ ABC BOOKLET
- ☐ CIRCUIT RIDER

TO:

NAME _____ TITLE _____

COMPANY _____

ADDRESS _____

Copyflex Machines and Sensitized Materials

ADD MANPOWER TO YOUR DRAFTING ROOM

Modern Reproduction Machines, Materials, and Techniques Cut

The boom in production means more pressure than ever for engineering prints and drawings. Now, more than ever, is the time to (1) replace that old, inadequate reproduction unit with a modern, efficient Copyflex machine and (2) capitalize on the many drafting shortcuts made possible by Copyflex reproduction machines and sensitized materials.

Six New, Advanced Machines: In just the past 18 months Bruning has introduced six new, greatly improved models—five of which are shown at right. They bring you not only faster reproduction but a host of design improvements that will boost your drafting room output sharply. One of these six new machines will surely meet your exact requirements.

Slash Re-Drafting Time: Your Copyflex machine is more than a means of making conventional opaque prints of finished drawings—it can also help you in your actual drafting operations. In many cases involving the re-working of existing drawings, for instance, it can save you up to 90% in tracing time through the use of translucent prints ("intermediates") made on film, cloth, or low-cost paper. Consider how much of your drafting is devoted to design changes, changes in standards, and similar alterations and you'll see why adding Copyflex to your production team will *add manpower to your drafting room.*

This design change took hours to make because it was done entirely at the drawing board.

The same design change was completed in less than an hour with the aid of a Copyflex intermediate.

These Materials Speed Reproduction *and* Drafting

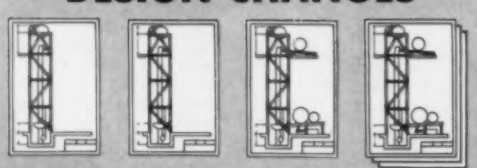
Copyflex Translucent Sensitized Paper: Prints made on this 100% rag, resin-transparentized medium provide: (1) a positive, reproducible image of all or any selected part of an original; (2) a workable drawing surface for making additions or alterations; and (3) excellent translucency for making fast, sharp reproductions. In the making of design changes, prints made on this paper eliminate the need for tracing those sections of the design which do not require alteration. Unwanted portions can either be masked out in the printing operation or eradicated on the translucent print . . . then new lines added. The paper prints accept pencil and ink, and drawn lines are erasable. Subsequent alterations are achieved just as easily and quickly by use of the same reproduction-drafting technique.

Copyflex Sensitized Matte Film: Usable for same purposes as Copyflex Translucent Sensitized Paper, but is highly transparent and much more durable. Reproduces faster than originals made on tracing paper.

Copyflex Sensitized Clear Film: Offers complete transparency and extremely fast reproduction speed. Not suitable for drawing, but ideal for making composite prints, overlays, and projection prints. Various developers can be applied to it to produce different color effects.

Copyflex Sensitized Tracing Cloth: A top quality moisture repellent cloth with excellent pencil and ink workability. The ideal material to use when circumstances require a translucent print with exceptional durability and strength.

HOW COPYFLEX SPEEDS DESIGN CHANGES



Original Drawing | Translucent Print of Original | Print with Alterations Drawn In | Prints Made from Altered Intermediate

Problem: To make a design change without marking or altering the original drawing or tracing.

Old Method: (1) Trace unchanged parts of the original by hand; (2) draw in the design changes or alterations.

Copyflex Method: (1) Reproduce unchanged parts of the original in a matter of seconds on Copyflex translucent paper, cloth, or film—blocking out or later eradicating any unwanted portions of the original design; (2) draw in the design changes or alterations.

Result: Substantial savings in time, money, and drafting room manpower.

NEW!

Desktop Model 300: Perfect for small firms, an ideal "extra" machine for large firms. Makes prints up to 30" wide by any length. Operates on 110 volt A.C.

Drafting Time, Boost Productivity!

NEW!

Model 500: A heavy-volume machine offering top mechanical speed of 40 f.p.m., 46" printing width, automatic separation and stacking, front or rear delivery, and many other advanced features.

Model 250: Takes less than a sq. yd. of floor space. Has top mechanical speed of 25 f.p.m., 18½" printing width, automatic separation and stacking. Operates on 220 volt A.C.

Model 200: A 110 volt A.C. version of the Model 250.

NEW!

NEW!

Model 35: Provides up to 30 f.p.m. mechanical speed and a full 46" print-width for heavy volume reproduction at a thrifty, low cost.

Model 20: Not a new model, but a dependable performer well worth your consideration. Makes prints up to 46" wide. Operates on 110 volt A.C.

Model 30: A faster, 220-volt version of the Model 20.

Desktop Model 110: A new and improved small machine with 11" printing width. Makes 8½"x11" prints for less than 1¢ each for materials. The helper your big machine needs!

NEW!

SEND FOR MORE INFORMATION TODAY!

BRUNING Copyflex

Best Process! Best Machines!
Best Selection of Materials!

Offices in 37 Cities of the U.S. and Canada

CHARLES BRUNING COMPANY, INC., 4700 Montrose Ave., Chicago 41, Ill.
In Canada: Charles Bruning Co. (Canada) Ltd., 105 Church St., Toronto 1, Ont.

Charles Bruning Company, Inc., Dept 33-0
4700 Montrose Ave., Chicago 41, Illinois

Please send me information on the Copyflex process and the following machine(s): _____
and sensitized materials: _____

Name _____ **Title** _____

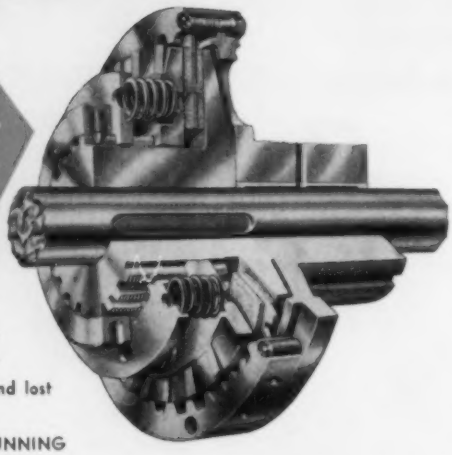
Company _____

Address _____

City _____ **County** _____ **State** _____

HILLIARD *Clutches*
FOR POWER CONTROL DESIGN

ADJUSTABLE *Slip Clutch*



- PROTECTS against overload, jams and down time.
- RESUMES THE DRIVE AUTOMATICALLY after overload.
- ELIMINATES SHEAR PINS and lost time.
- ADJUSTABLE - WHILE - RUNNING feature is available.

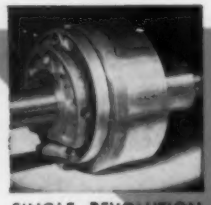
Hilliard Slip Clutches are continuously protecting the drive on dish washing machines—printing presses—packaging machines—case loaders—foundry equipment— air filters—conveyors—overhead doors—and many others.
They maintain steady torque while permitting speed variation on fabric drying drums, steel strip slitters and similar equipment.

The adjustable-while-running types are used to maintain constant tension on rewind stands for paper coaters, textile machines, rope, steel and wire mills and for drive systems requiring overload protection but which must be disconnected at times.

WRITE TODAY FOR BULLETIN 300 WITH COMPLETE INFORMATION.

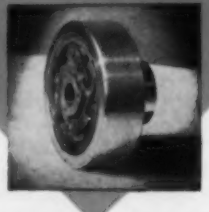
● OTHER HILLIARD CLUTCHES ●

CONSIDER AUTOMATION - INVESTIGATE THESE PRODUCTS



SINGLE REVOLUTION CLUTCHES for automatic accurate control—electrical or mechanical—of intermittent motion, indexing, cycling and cut-off. Ask for Bulletin 239.

HILLIARD - TWIFLEX CENTRIFUGAL COUPLING for smooth, easy starting of any load automatically with overload protection and ability to accommodate shaft misalignment. Ask for Bulletin CE-3.



OVER - RUNNING CLUTCHES for automatic instantaneous engagement and release on two speed drives, dual drives and ratchet, or backstop action. Ask for Bulletin 231.

THE HILLIARD *Corporation*

MANUFACTURING CLUTCHES FOR OVER 50 YEARS

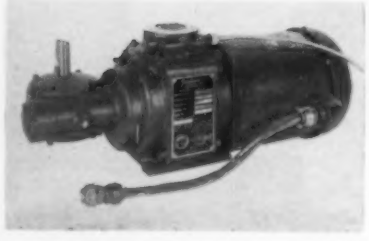
101 W. FOURTH ST. ELMIRA, N. Y.

IN CANADA: UPTON • BRADEEN • JAMES, LTD.

by two AN 3140 lamps—both replaced from the front of the panel.

The body is anodized aluminum and mounts by two machine screws. Lenses are available in amber, blue, green, red or white translucent plastic. Hetherington, Inc., Sharon Hill, Pa.

For more information—
Circle 69, inside back cover



Variable Speed Drive For 400 Cps

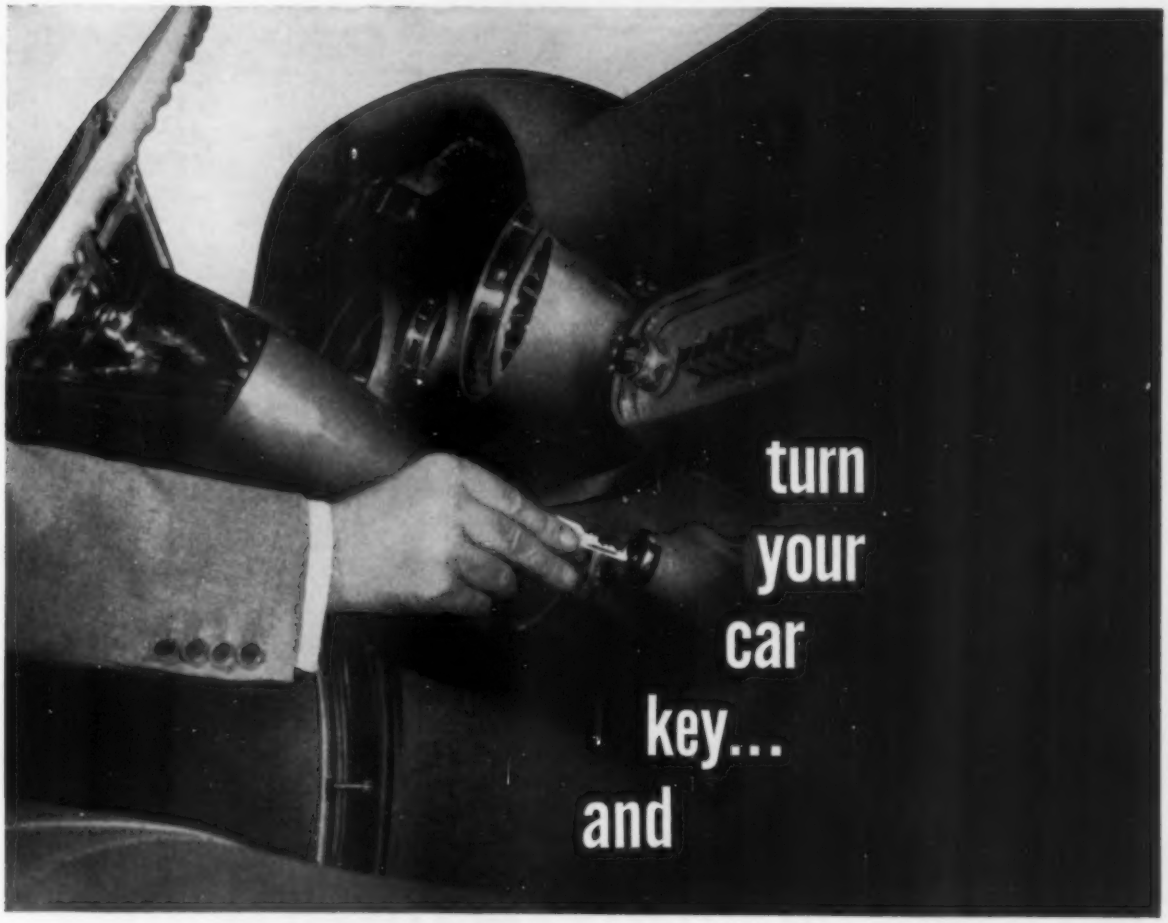
Designed for air force ground checkout and test equipment, this drive delivers speeds from any desired maximum to zero and into full reverse, if desired, without change of motor rotation. It is particularly suited for use on tachometer, gyro and accelerometer testers as well as integrating devices and other similar apparatus. Sizes from 1/15 to ½ hp with torques up to 750 in-lb. Graham Transmissions Inc., Menomonee Falls, Wis.

For more information—
Circle 70, inside back cover

Digital Comparator

Designed for use in digital servo control systems, this comparator makes possible true digital control without recourse to counting techniques. In conjunction with this manufacturer's shaft-position-to-digital converter, the device can provide digital control through conventional

(Continued on page 272)



Synthane laminated plastics report for work

Breaker Arms for tractors and outboard motors are cut from lengths of molded laminated. Breaker arm bushings and rubber angles are important ignition components.

A turn of the ignition key and the thousands of parts which make up your car go to work as a team. Under the dash or under the hood are dozens of parts made of Synthane laminated plastics. They may seem insignificant but they're as necessary as an owner's license.

Take away Synthane laminated plastics and you have a car that won't start, a generator that won't run, lights that won't light, or a silent radio or motionless fan—which may give you some idea of the importance of a product like Synthane in the automotive industry.

Synthane laminates are excellent electrical insulators—they resist moisture—smile at oil—are easy to machine and mechanically strong. Synthane laminated plastics are available in sheets, rods and tubes or as parts completely fabricated to your designs and specifications.

For more information about the many properties of Synthane laminated plastics and how you can benefit by using Synthane materials and fabricating services, write for our latest product catalog. Synthane Corporation, 4 River Road, Oaks, Pa.

EASILY MACHINED

DIELECTRIC STRENGTH

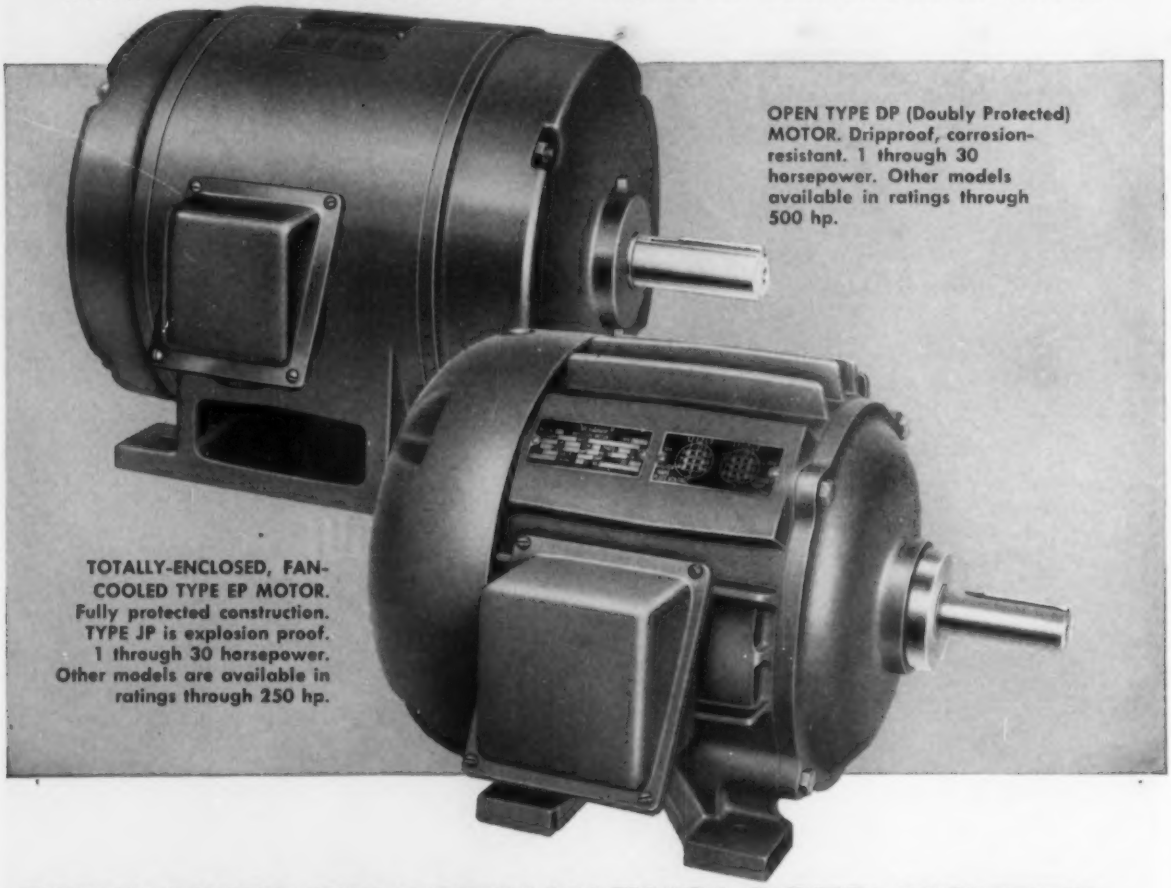
OIL RESISTANCE

DIMENSIONAL STABILITY

SYNTHANE ... industry's unseen essential.

SYNTHANE CORPORATION, 4 RIVER ROAD, OAKS, PA.

WAGNER ELECTRIC MOTORS...THE CHOICE OF LEADERS IN INDUSTRY



OPEN TYPE DP (Doubly Protected) MOTOR. Dripproof, corrosion-resistant. 1 through 30 horsepower. Other models available in ratings through 500 hp.

TOTALLY-ENCLOSED, FAN-COOLED TYPE EP MOTOR. Fully protected construction. TYPE JP is explosion proof. 1 through 30 horsepower. Other models are available in ratings through 250 hp.

OPEN TYPE OR TOTALLY ENCLOSED MOTORS...

Wagner offers MORE for your motor dollar!

- **MORE POWER IN LESS SPACE**... These motors are built in NEMA frame sizes 182 through 326 U. They pack more power into less space for easier handling and stocking—require less space for installations.
- **CORROSION-RESISTANT FRAMES** ... Both types are built with rugged, corrosion-resistant cast iron frames. Motor feet are cast as an integral part of the frame for maximum strength and rigidity.
- **THE TYPE OF PROTECTION YOU NEED** ... Type DP motors have completely dripproof—virtually splash-proof enclosures; while type EP is totally enclosed, fan-cooled for complete protection; and type JP adds explosion proof features.
- **COOLER OPERATION**... Special baffles direct a cooling flow of air through the DP motor. Types EP and JP are fan-cooled and have ribbed frames to increase the surface area for more efficient cooling.
- **LONGER BEARING LIFE**... These motors can be re-greased when desired to prolong bearing life. Fresh grease can be added—old grease removed through openings provided in the bearing housing.
- **WAGNER DEPENDABILITY**... These two motors have the same high Wagner quality, will give the same long life performance, that have made Wagner Motors a known value for sixty-five years.
- Let a Wagner field engineer, expert on motor applications, show you how these motors can be applied to your needs. Call the nearest of our 32 branch offices, or write us. Bulletins MU-202 and MU-203 give complete information on these Wagner Motors. Write for your file copies today.

M57-A

Wagner Electric Corporation
SERVING INDUSTRY SINCE 1891

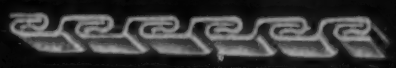
BRANCHES AND DISTRIBUTORS IN ALL PRINCIPAL CITIES

Wagner Electric Corporation
6406 Plymouth Ave., St. Louis 14, Mo., U.S.A.

ELECTRIC MOTORS • TRANSFORMERS • INDUSTRIAL BRAKES • AUTOMOTIVE BRAKE SYSTEMS—AIR AND HYDRAULIC

EXTRA HEAVY DUTY

HEAVY DUTY

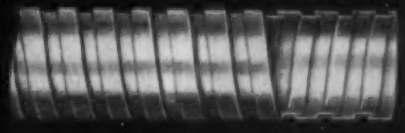


LIGHT DUTY

MEDIUM DUTY

PENFLEX

LIGHTWEIGHT EXHAUST



SQUARE LOCKED CASING

RUGGED FLEXIBILITY

FOR EVERY INDUSTRY'S REQUIREMENTS

Tough as a pipe, but flexible, that is Penflex tubing. You name your need for conveying volatiles, liquids, chemicals, powders, granular materials, or semi-solids . . . hot or cold . . . and Penflex has the right tubing to provide the maximum service. It is unsurpassed for withstanding rough abuse, abrasion, crushing and heat.

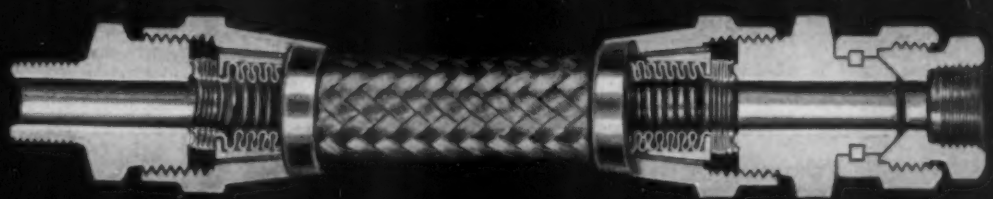
Squarelocked, interlocked, corrugated . . . packed or unpacked . . . braided or unbraided . . . with all types of couplings. Penflex makes them to meet your exact specifications and scientifically engineers them to the installation with "Flexineering." If you need flexible metal tubing from ⅛" to 24" I.D. . . . bronze, galvanized or stainless steel call on your Penflex man. For data on the complete line of products . . . plus valuable specifications on flexible tubing write for your copy of "Flexineering."

PENNSYLVANIA FLEXIBLE METALLIC TUBING COMPANY, INC.

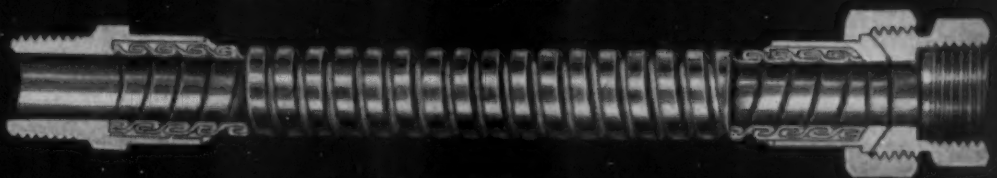
7239 POWERS LANE, PHILADELPHIA 42, PA.

Branch Sales Offices: Boston New York Chicago Houston Cleveland Los Angeles

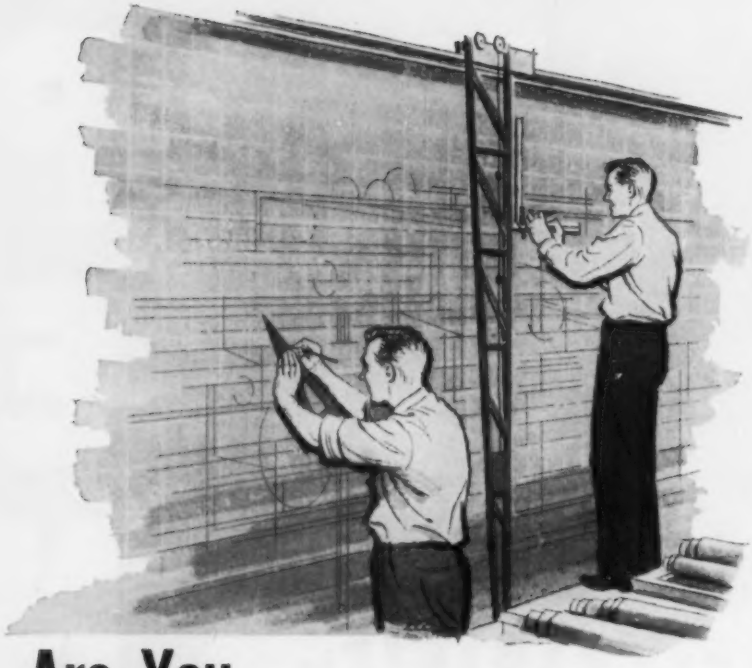
and Distributors in Principal Cities



PENFLEXWELD WITH HEATPROOF COUPLINGS



M-100 WITH SOLDERED COUPLINGS



Are You an Engineer's Engineer?

Then you will enjoy meeting the men at Pioneer. Here are gathered together the most versatile and competent staffs of product development and design engineers you can imagine.

They are real engineers' engineers. There is nothing in the world to them like getting their teeth into a product design and development, or improvement project.

As every engineer's engineer has to be, they are thoroughly practical. If you wish, they can help you right from the sketch or idea stage through all phases, including a complete set of manufacturing drawings. What's more, these drawings will guarantee the most economical production costs. They can help you with development, with styling for today or tomorrow, with engineering analysis, production methods and tools, on prototype building and testing, performance analysis and specifications.

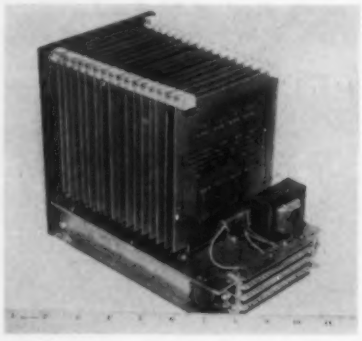
Industry has called on them on over 264,000 jobs in the past 25 years. Working with engineering staffs like yours, they are trained to assemble ideas from their experiences in dozens of fields and apply them to the development of a better, more economical, more saleable, MORE PROFITABLE product in a still different field . . . yours!

You can write your own specs as to what you want them to do for you, and how. They'll be part of your team. They are a real engineer's engineers . . .

P. S.—Pioneer's Chief Engineer has some material he'll be glad to send you, giving more details on our services. Ask him for Bulletin PE-60

SINCE 1931 Pioneer ENGINEERING & MANUFACTURING CO., INC.
Telephone - TWinbrook 3-4500
19669 John R Street, Detroit 3, Michigan

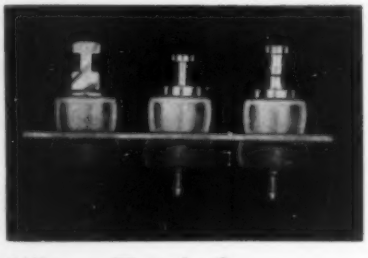
INDUSTRIAL ENGINEERS, CONSULTANTS & DESIGNERS
BRANCH OFFICES IN DAYTON, OHIO, WASHINGTON, D. C. and TORONTO, ONT., CAN.



servo amplifiers and motors. A 19-bit comparator allows control to one part in 524,288.

A built-in preamplifier provides adjustable gain up to 5 v max at 1,000 ohm output impedance. The comparator has zero dead time, with a band width limited only by carrier frequency up to several kilocycles. Voltage requirements are –40, –20, and 20 v d-c, and 115 v at carrier frequency. Norden-Ketay Corp., Commerce Road, Stamford, Conn.

For more information—
Circle 71, inside back cover



Silicone Terminal

This hermetically sealed terminal is for electronic components such as transformers and capacitors, in the intermediate voltage range. The terminal is available in three electrode styles: hollow electrode with lug for minimum clearance; solid electrode with single turret; solid electrode with double turret. Lundey Associates, 694 Main St., Waltham 54, Mass.

For more information—
Circle 72, inside back cover

Time Delay Relay

This relay has single-pole, double-throw, snap-action contacts. The relay is thermally operated, having two separate heater circuits. Each heater

(Continued on page 276)

the NEW AMPlivar splice plus new horizontal machine

for identical, mass produced splices of enamel, poly-vinyl acetal and similarly coated wire

AMPlivar splices can be used on solid or stranded conductors, or combinations thereof.

AMPlivar splices, with multiple ring stripping action, eliminate scraping, dissolving in solvents, burning, or other methods for removing insulation. Included among its many other features are:

- NO HEAT DAMAGE TO WIRE OR INSULATION—as often occurs in alternate methods of splicing.
- SMALL SIZE—scarcely larger than the wires themselves, but design-engineered to lock wire and connector into a high tensile strength splice.
- CORROSION RESISTANT—the joint is hermetically sealed during splicing.
- LOWER INSTALLED COSTS—eliminates soldering materials and equipment . . . requires less wire . . . reduces time required to make the splice.

Further information is available on request.

This cutaway of the AMPlivar splice shows how conductor material extrudes outwardly into serrations for added strength and electrical contact. The splice is as corrosion resistant as the wire itself.

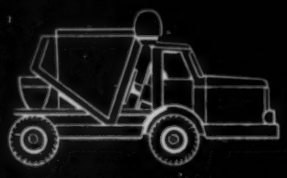
IDEAL FOR ASSEMBLY LINE PRODUCTION . . . the AMP Horizontal Automachine uses AMPlivar splice connectors in strip form, for automatic splicing as fast as the operator can insert the wires.

AMP INCORPORATED AMP

General Office: Harrisburg, Pa.

Wholly Owned Subsidiaries: Aircraft-Marine Products of Canada Ltd., Toronto, Canada • Aircraft-Marine Products (G.B.) Ltd., London, England • Societe AMP de France, Le Pre St. Gervais, Seine, France • AMP—Holland N.V. 's-Hertogenbosch, Holland
Japanese Distributor: Oriental Terminal Products Co., Ltd., Tokyo, Japan

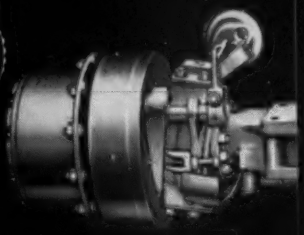
FROM TIMKEN-DETROIT®...



today's

BROADEST RANGE

OF



PLANETARY AXLES

...both steering and rigid!

FOR HEAVY-DUTY SPECIAL EQUIPMENT AND TRUCK APPLICATION

The Timken-Detroit family of advanced design axles now includes a complete range of new planetary heavy-duty axles—with a steering axle operationally matched to each rigid axle in the line.

Versatility, ruggedness, and almost unlimited gear reductions make these new planetary axles the leaders in their line. They are going into use in practically every corner of the world on heavy-duty two- and four-wheel drive prime movers, husky off-road rock and earth wagons, big four-wheel tractors, mining equipment, heavy-duty scrapers, front-end loaders and many other units of heavy-duty equipment.

Years of TDA® research and development have brought these new and exclusive planetary outer-end features: floating ring gears—concentrically mounted ring gear hubs—full-flow lubrication of all bearings and planet gears—special forged bronze planet pinion pins—and an unusually high degree of parts interchangeability. For the newest and finest in planetary axles—depend on Timken!

Only New Timken® Full Planetary Design Brings You These Features for Extra-Long Life, and Extra Dependability:

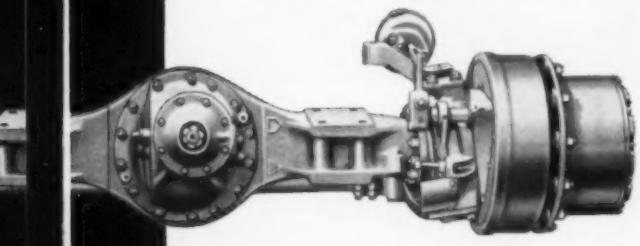
1. NEW FLOATING RING GEAR and hub are two separate pieces. Ring gear is free to float radially. This feature, combined with floating sun gear, assures equal distribution of stresses to all planetary gears, gives longer, trouble-free gear life.

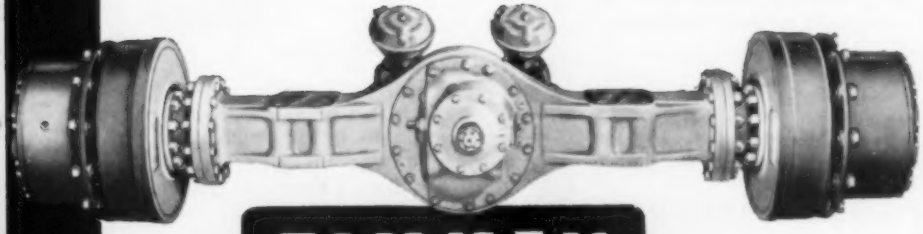
2. CONCENTRICALLY GROUND RING GEAR HUB AND SPINDLE MOUNTING SURFACES ground around a common center assures perfect alignment and fit—plus freedom from bending forces on the hub and spindle splines. Splines absorb only torsional stresses from the ring gear and transmit them to the housing.

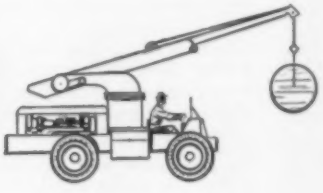
3. SPECIAL FORGED BRONZE PLANET PINION PINS of premium alloy bronze for longer, trouble-free operation. Rifle drilled lubrication channels and machined lubrication flats assure full time lubrication. When cover is assembled pin is locked in place to prevent rotation—resulting in longer pin life.

4. FULL-FLOW LUBRICATION design of Timken planetary axles assures constant flow of lubricants to wheel bearings and all planet gears while vehicle is in operation. Wheel hub and planetary spider pick up oil in the cast reservoirs as they rotate and channel it to all moving parts. When vehicle is not in motion oil is retained in these chambers providing ample initial lubrication.

5. HIGH DEGREE OF PARTS INTERCHANGEABILITY between both rigid and steering axles in the same series. This means a smaller parts inventory, low maintenance costs and more productive time with Timken planetary axle equipped vehicles.







TIMKEN Detroit AXLES

TIMKEN-DETROIT AXLE DIVISION
ROCKWELL SPRING AND AXLE COMPANY
ASHTABULA, OHIO

The Accepted Standard

Plants at: Detroit, Michigan • Oshkosh, Wisconsin
Utica, New York • Ashtabula, Kenton and Newark, Ohio
New Castle, Pennsylvania

WORLD'S LARGEST MANUFACTURER OF AXLES FOR TRUCKS, BUSSES AND TRAILERS

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NATIONWIDE
SERVICE by ARWOOD
. . . our reputation is
built on it
. . . our future
depends on it
Fifty-four skilled and experienced ARWOOD field engineers are at your service in 20 major industrial centers throughout the country. They are experts in design and production engineering, with a fund of Investment Casting knowledge at their fingertips, to do only one thing —Help you!
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• Largest field-engineering staff in the industry
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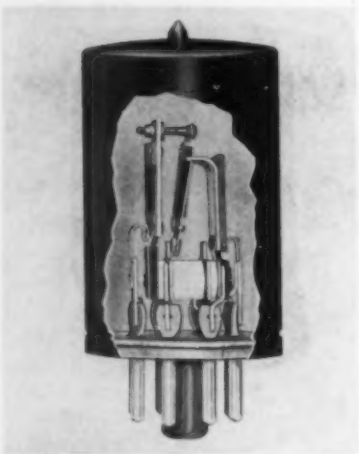
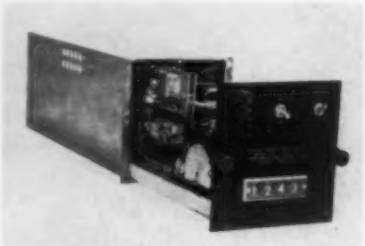


serves to transfer a movable arm from one contact to the other. The relay being bistable, it remains in either of the two contact positions until operated by appropriate heater circuit Because of the thermal actuating characteristics, a time delay is associated with each operation.

The operating time of the unit is factory preset for either 20 or 30 sec on both transfers. The relays are temperature-compensated from −55 C to 100 C and have standard voltage rating of 6, 3, 26.5, or 117 v. Heater power is 2.7 w for each heater. Curtiss-Wright Corp, Carlstadt, N.J.

For more information—
Circle 73, inside back cover



Digital Indicator

Requiring 7 x 7 in. panel space, the indicator permits direct reading of signals from a variety of transducers, for wide application in the measurement of temperature, pressure, load, speed flow, or any other variable which can be translated into an electrical quantity. Digital presentation of analog quantities is accomplished by an electronic null balance servo system driving a precision set of

(Continued on page 278)

You already depend on a Leland explosion-proof!

7 of every 10 gasoline pumps are powered by Leland

Next time you have your gas tank filled – quickly and safely, whatever the weather – odds are *better than 2 to 1* that a *Leland* motor will pump the gasoline.

For ever since Leland introduced the *first* explosion-proof gasoline pump motor, over 30 years ago, Leland gas pump motors have *outsold all others combined!*

Odds are you'll find Leland your finest source for explosion-proof motors of *all* kinds – from pumping volatile liquids and gases to powering equipment in hazardous atmospheres. There's a complete line of explosion-proof motors from ⅛ to 5 hp – and, if necessary, the experienced engineering ability to *develop* an explosion-proof motor to meet your most demanding requirements.

Next time you need a motor, standard *or* special, explosion-proof or otherwise, try Leland.

Leland explosion-proof gasoline pump motor, Underwriters' Approved for Class 1, Group D. Capacitor start, induction run, with built-in voltage changer and on-off switch.

Another AMF Product

LELAND MOTORS

THE LELAND ELECTRIC COMPANY
Dayton 1, Ohio
Division of AMERICAN MACHINE & FOUNDRY COMPANY

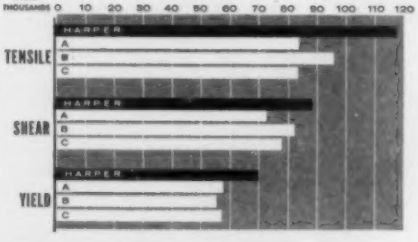
Immediate delivery from 150,000,000 standard items in Stainless, Monel, Aluminum, Brass, Bronze, Copper!

Thousands of Harper corrosion-resistant fastenings are in Harper Distributor stocks across the country! Even more thousands are continually on hand at The H. M. Harper Company for your convenience! A phone call to your Harper Distributor will do the trick! Why shop? Why wait? For immediate delivery, specialized service—call your Harper Distributor now!

THE H. M. HARPER COMPANY
8203 LEHIGH AVENUE • MORTON GROVE, ILLINOIS

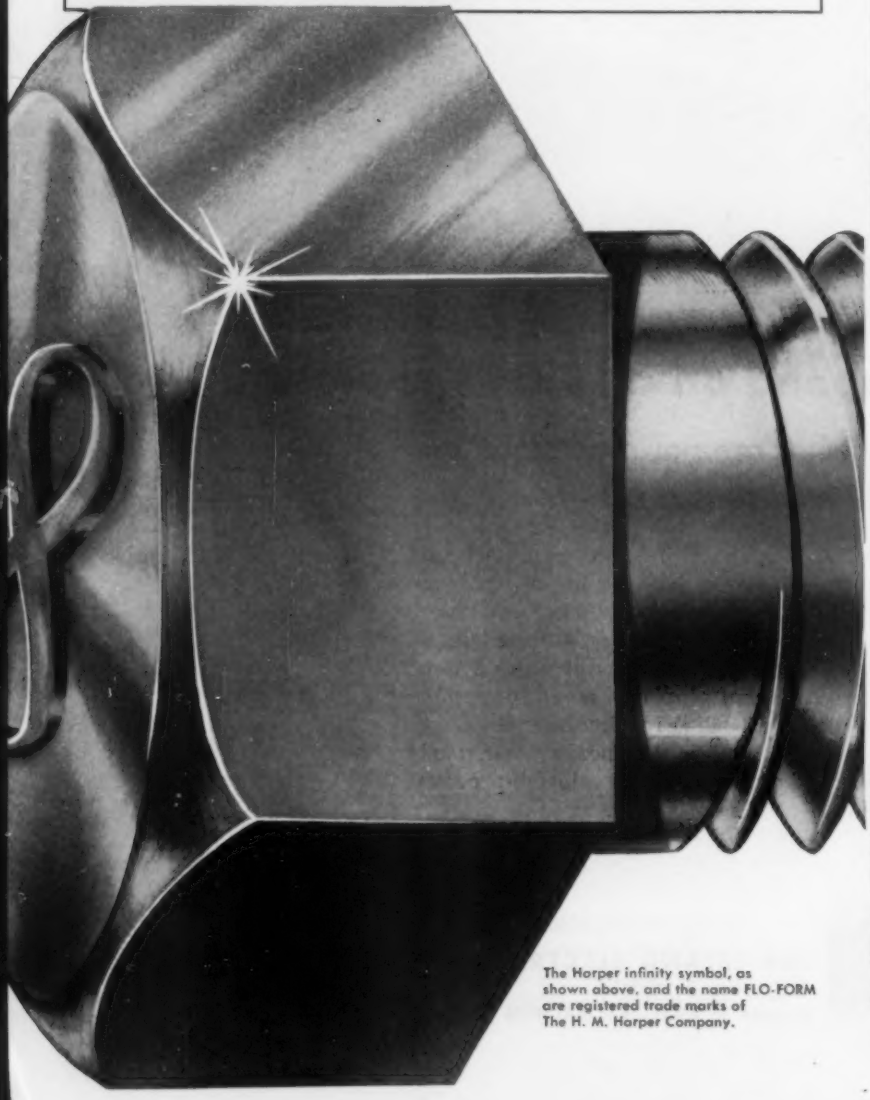
HARPER

Irrefutable proof of Harper's greater metals' strength shown by laboratory test!



An important point in buying fastenings is strength. Independent laboratory tests*, utilizing Stainless Steel Machine Bolts by Harper and three other leading producers, prove Harper superiority in Tensile, Shear, and Yield Strength. The chart at left shows the actual results of these tests. For complete information on these important tests, request Form No. 126.

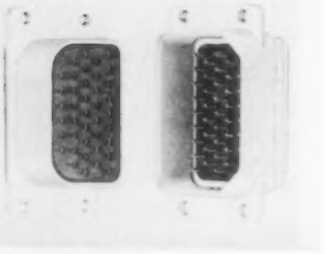
*By R. W. Hunt Laboratories



The Harper infinity symbol, as shown above, and the name FLO-FORM are registered trade marks of The H. M. Harper Company.

geared number wheels. Non-linear inputs are made linear by a tapped slidewire. A shaft-digitizer mounted in the instrument will provide outputs which can be fed directly to print-out equipment. Performance Measurements Co., 15301 W. McNichols Road, Detroit 35, Mich.

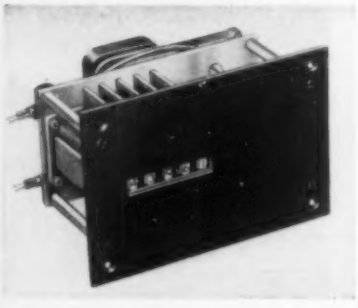
For more information—
Circle 74, inside back cover



Rack and Panel Connector

A rack and panel electrical connector, incorporating a solid shell and resilient insert, has gold-plated contacts, cadmium-plated finish, operates in temperature range of –67 to 250 F. Scintilla Div., Bendix Aviation Corp., Sidney, N.Y.

For more information—
Circle 75, inside back cover



Digital Counter

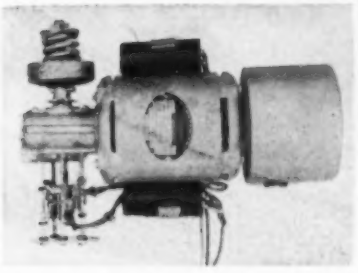
A series of electrical data readout counters perform functions of direct indication, remote indication, recording and controlling. Either electrically or mechanically actuated and offering manual or electrical reset, the new units automatically create specific contact closures for each reading visually displayed.

Serial or parallel transmission of data can be accomplished through the use of sequence scanners or direct connections. Transmission may be

(Continued on page 279)

continuous or intermittent with the counter providing data storage. Veeder-Root, Inc., Hartford 2, Conn.

For more information—
Circle 76, inside back cover



Fhp Gearmotors

These gearmotors have a shaft output speed of 144 rpm, and can be made instantly reversible. They may be equipped with a magnetic disc brake for instant stopping and with a friction clutch as a safety factor. For automatic operation, they are equipped with limit switches which are actuated by a bronze nut that travels on an extension of the output shaft. Brown-Brockmeyer Co., Dayton, Ohio.

For more information—
Circle 77, inside back cover

Arming Solenoid

The arming pin projects when the solenoid is energized (15.5 to 28 v d-c) and will support a 100 lb, ring-hung load. When the solenoid is de-energized, the pin retracts under a 5 lb, ring-hung load. Dimensions are 1.6 x 1.6 x 0.9 in.; weight is 4 oz. United Transformer Corp., 4008 W. Jefferson Blvd., Los Angeles 16, Calif.

For more information—
Circle 78, inside back cover

Portable Electronic Switch

Essentially an ultra-sensitive, heavy-duty electronic switch, the device

(Continued on page 280)

HARPER

CORROSION-RESISTANT FASTENINGS

SPECIAL PARTS? Harper's exclusive Flo-Form Process solves these problems at big savings!

There's no part too tiny, too large, or too complex for Harper Flo-Form! This remarkable process could only be developed by Harper, with its wealth of thirty-three years' experience in corrosion-resistant fastenings. Where others mill from bar—Harper Flo-Form produces by cold or hot forging under tremendous pressures. The results?—a *better* product, *faster*, at *lower cost!* Place your "special problem" in the hands of the Harper Flo-Form team of design engineers, metallurgists, and tooling specialists. Write Harper, or call your nearby Harper Branch for Harper Application Engineering Service. Your problem is *our* problem.

THE H. M. HARPER COMPANY

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Meet Harper Application Engineer, LEON HAMLET

Every day sees new special parts problems submitted to Mr. Leon Hamlet of the Harper Branch in Milwaukee. Mr. Hamlet in turn, works with the Harper Flo-Form Engineering Team to provide the *right answer* at the *lowest possible cost.*

ACE-HIDE®

the new molding material that's both **TOUGH** *and* **GENTLE**

Ace-Hide acid pail

Molded top for golf bag

Large molding is lid for beverage cooler

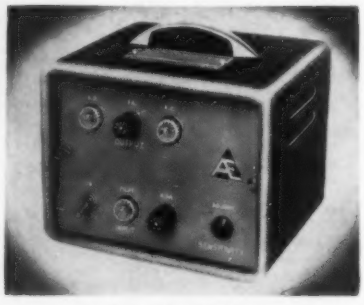
Ace-Hide is a new rubber-plastic molding material designed to take a beating without showing it. Its toughness, smoothness, resilience and excellent chemical resistance have already led to wide-spread use for things like chair arm pads, scuff guards, acid pails and golf bag tops.

Ace-Hide is a special blend of rubber with plastic, hence is light in weight and has good electrical and thermal insulating properties. Rigidity and impact strength (to 10.0 Izod) can be varied to suit. Takes inserts well. Surface is smooth, shiny. Does not develop flexing cracks, and ages well. Ace molding facilities offer wide range of sizes and shapes. We'll be glad to make specific recommendations. Write today.

Ace-Hide and many other hard and soft rubber, plastics, and rubber-plastic blends are described in 80 pg. ACE Handbook. Write for your copy today!

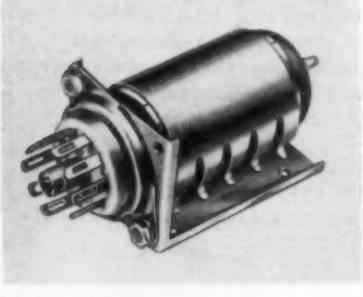
ACE® rubber and plastic products

AMERICAN HARD RUBBER COMPANY
93 WORTH STREET • NEW YORK 13, N. Y.



will control up to 500 w of power, delivered at 115 v a-c, 60 cps, or switched by its internal contacts. Minimum input impedence is 2 megohm. A rear-mounted terminal strip provides for selection of switching functions. Autron Engineering Inc., 1254 W. 6 St., Los Angeles 17, Calif.

For more information—
Circle 79, inside back cover



Right-Angle Tube Shield Mount

A heat-dissipating shield mount for miniature electron tubes incorporating an integral right-angle mounting bracket and socket is available for all sizes of 7 and 9-pin miniature electron tubes. International Electronic Research Corp., 145 W. Magnolia Blvd., Burbank, Calif.

For more information—
Circle 80, inside back cover

High-Limit Temperature Control

This control is UL-approved for 15 amp at 115/230 v a-c, in what is classified as stand-by service. The device is designed to be connected in series with a primary temperature control. It is particularly adaptable for use with ovens. Its function, in this

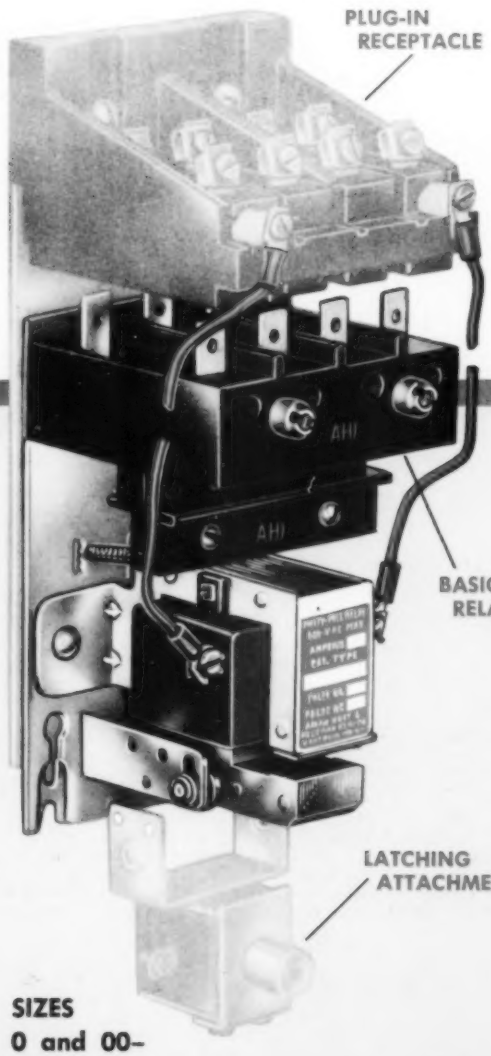
(Continued on page 283)

Announcing

THE COMPLETE MACHINE TOOL RELAY

by ARROW AH HART

A NEWER, FINER ADVANCED-DESIGN COMPONENT THAT DOES MORE DIFFERENT TYPES OF JOBS . . . *BETTER!*



SIZES
0 and 00–
600 V AC

Check these features for

ADAPTABILITY —

- **CONTACTS QUICKLY CONVERTIBLE** . . . from normally-open to normally-closed, no tools needed. No loose parts. Exclusive center positioning device guards against contact damage while converting.
- **OPTIONAL LATCHING ATTACHMENT** . . . *another A-H exclusive,* allows quick conversion of contactor to latching type. This attachment is quickly changed from **latch-in** to **latch-out** operation or **latched-in and out.**
- **PLUG-IN/SCREW-TYPE TERMINALS** . . . can be used for plug-in and screw-type as desired.
- **MOST COMPLETE LINE AVAILABLE** . . . Removal of Terminal Screws from Standard Relays converts use to plug-in relays. In 2, 3, 4, 6 or 8 poles . . . in IMP (Interchangable Pole) or FMP (Fixed Pole) types. The **BASIC RELAY** is suitable for use by itself.

FAST, EASY INSTALLATION and SIMPLE MAINTENANCE —

- **OPTIONAL PLUG-IN RECEPTACLE** . . . minimizes down-time on high-output machines, since entire contactor unit can be replaced in minutes without disturbing wiring.
- **EXCLUSIVE FRONTAL SWING-OUT** . . . permits fast, easy removal of entire coil.
- **EXPOSABLE MAGNET POLE FACES** . . . for inspection or cleaning.
- **SELF-CONTAINED CONTACT CAGE** . . . with no loose springs, screws or other parts to get lost.
- **MORE COMPACT SIZE** . . . allows easy location, leaves more space for easier wiring.
- **SEPARATE TERMINALS for CONTROL CIRCUITS AND COILS** . . . without using extra poles.

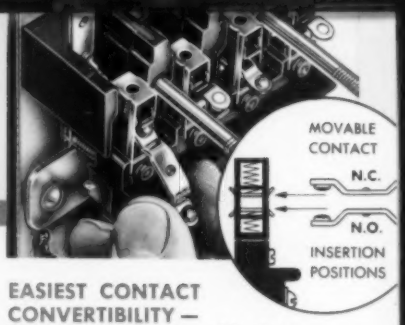
EFFICIENT, DEPENDABLE OPERATION —

- **ALL CURRENT-CARRYING PARTS SILVER PLATED** . . . for highest capacity and minimum heating.
- **FRICTION-FREE, DUST-RESISTANT OPERATING MECHANISM** . . . with positive, fail-safe action.
- **ABSOLUTE ALIGNMENT OF PLUG-IN PRONGS** . . . insured by combined receptacle and mounting plate.
- **CONTACTS and GUIDING FRAMES** . . . of special heat-tempered materials to minimize wear and assure smooth action.
- **HIGH-EFFICIENCY SOLENOID MAGNET and MOLDED, LOW-WATTAGE COILS.**

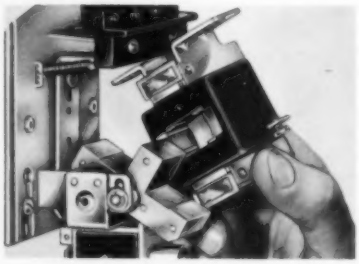
PLEASE TURN THE PAGE FOR ADDITIONAL INFORMATION

Greatest Versatility

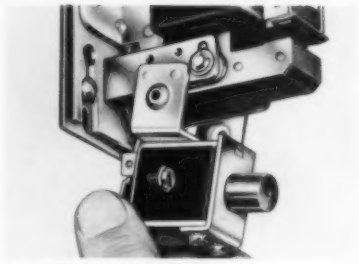
ever offered in a SINGLE RELAY DESIGN!



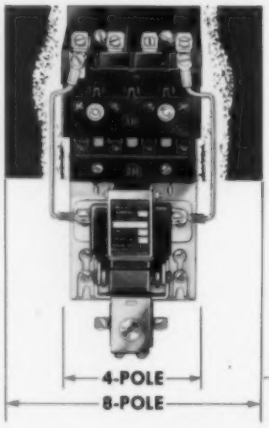
EASIEST CONTACT CONVERTIBILITY —
No tools needed — No loose parts to get lost.



FASTEST COIL ACCESSIBILITY —
Simply remove 2 screws, swing to front and lift out!



HANDIEST LATCHING ATTACHMENT —
Quickly converts any of these contactors to latching type — attachment simply converted in the field *— latch-in, latch-out, or latched both ways as desired.*

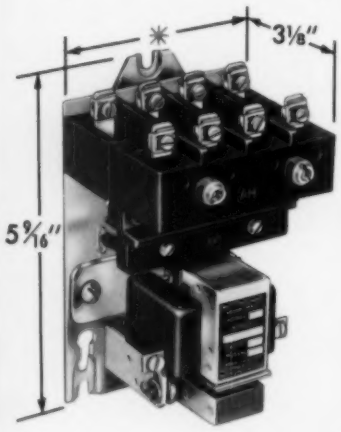


Available

- in AC and DC types
- with 2, 3, 4, 6 or 8 poles
- SIZE 00 (10 Amp) or SIZE 0 (15 Amp)
- IMP (Convertible and Renewable) Type or FMP (Fixed and Renewable) Type
- with Optional Plug-In Receptacle— Type IMP-100 Series
- with Optional Latching Attachment — Cat. #IMP-11 (Specify Coil Voltage)

COMPARATIVE WIDTHS

4-POLE and 8-POLE RELAY with OPTIONAL PLUG-IN RECEPTACLE and LATCHING ATTACHMENT



* SEE TABLE

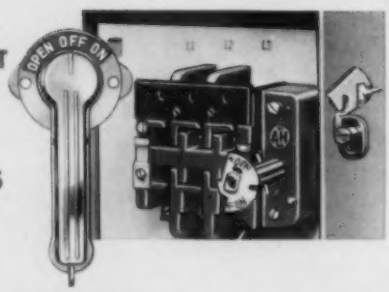
INTERCHANGEABLE MULTI-POLE RELAYS

No Other Relay Offers This Versatility In 2, 3, 4, 6 and 8 Poles	Size 00 10 Amp	Size 0 15 Amp	Applicable in Field	Applicable to Standard Relay
Relay—Type IMP CONVERTIBLE and RENEWABLE Contacts	X	X		
Relay—Type FMP FIXED and RENEWABLE Contacts	X	X		
Optional Plug-In Receptacle	One for both		X	X
Optional Latching Attachment	One for both		X	X

No. of Poles	2 to 4	6	8
Width	3"	4½"	6"

Receptacle adds 2¼" to height and ½" to depth. Latch adds 1¼" to height.

ARROW-HART TYPE "RAD" DOOR DISCONNECTS MEET JIC STANDARDS



the ultimate in —

SAFETY — ALWAYS-VISIBLE CONTACTS give operator constant visual assurance of safety. EASY-TO-SEE HANDLE INDICATORS clearly show "On", "Off", and "Open" positions. SAFE "OFF" FEATURE prevents opening door until handle is purposely turned to "Open" position. LINE COVER prevents accidental contact with live wires.

MINIMUM MAINTENANCE — RUGGED, BUTT-TYPE SILVER CADMIUM OXIDE CONTACTS provide highest possible weld resistance. CONTACTS EASILY REPLACEABLE without disturbing wiring. DISCONNECT HANDLE is oiltight.

EASY INSTALLATION — Both 30 and 60 amp sizes have identical mounting dimensions, making standardization easy. Mounting requires only 3 small holes and 2 screws. Easy-locating feature for hole location. Three adjustable operating shafts take care of variations in panel depth.

THE ARROW-HART & HEGEMAN ELECTRIC COMPANY
103 Hawthorn Street, Hartford 6, Connecticut
MOTOR CONTROL DIVISION

Please send me complete engineering data on:

☐ A-H Type "IMP" and "FMP" Contactors
☐ A-H Type "RAD" Door Disconnects

NAME _____
POSITION _____
COMPANY _____
CO. ADDRESS _____
CITY _____ ZONE _____ STATE _____

ARROW AH HART

Quality since 1890

WIRING DEVICES • MOTOR CONTROLS • ENCLOSED SWITCHES • APPLIANCE SWITCHES

case, is to detect predetermined oven temperatures and to lock open the circuit to prevent damage. A built-in pilot light warns the operator that a safety control has cut off the oven heat. By pressing the reset button, the circuit will be restored only if the temperatures have dropped below the danger zone. United Electric Controls Co; 79 School St., Watertown 72, Mass.

For more information—
Circle 81, inside back cover

Insulating Connectors

The insulating body is molded Teflon, a chemically inert compound serviceable from −100 F to 500 F. Joclin Mfg. Co., N. Haven, Conn.

For more information—
Circle 82, inside back cover

Vacuum-Tube Voltmeter

This voltmeter can be mounted in operating or test equipment without exceeding the area required by a standard panel meter. Accuracy is 2 per cent, range from 0.5 to 300 v.

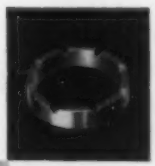
(Continued on page 284)

a new expanded field of

BEARING DESIGN and APPLICATION

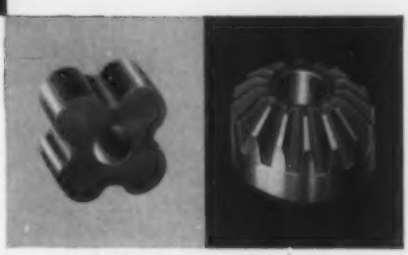
The inauguration of Bunting's new facility for engineering and manufacturing bearings and parts of Sintered Powdered Metals opens a wide new area of opportunity to all mechanical industry.

Sintered Powdered Metal Bearings and parts offer real economies in design. Bunting Engineering and manufacturing skill and traditional technical responsibility assure your most advantageous use of this material.



A competent group of Bunting Sales Engineers in the field and a soundly established Product Engineering Department put at your command, comprehensive data and facts based on wide experience in the designing and use of both Cast Bronze and Sintered Powdered Metal Bearings and parts.

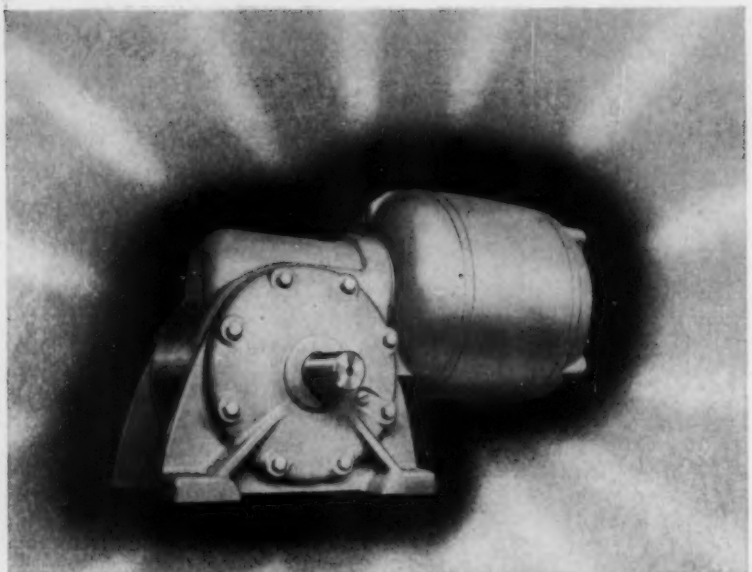
● *Write for catalogs and your copy of the new 24 page Bunting Engineering handbook of Sintered Powdered products and their composition, manufacture and application.*



Bunting®

BUSHINGS, BEARINGS, BARS AND SPECIAL PARTS OF CAST BRONZE AND POWDERED METAL

The Bunting Brass and Bronze Company • Toledo 1, Ohio • Branches in Principal Cities



FIRST IN ALUMINUM
FOREMOST IN QUALITY

ELECTRA-GEARMOTOR *housings are cast of heat treated alloy of aluminum, distinctive because of:*

- More resistance to corrosion
- Higher tensile strength
- Better shock resistance
- Faster heat transfer
- Superior finish
- Lighter weight

Excellence in modern design is yours when you choose ELECTRA-GEARMOTORS *with these quality features:*

- Exclusive GLAMICONE insulation
- Superior high density rotors
- Extra splash-proof protection
- Precision heavy-duty gearing
- Double protection against oil leakage
- Micro-finish on shafts for oil seals
- High speed ball bearings
- Low speed tapered roller bearings
- Special "tang" shaft-rotor to worm shaft

These and many more refinements combine in motor and geareducer to bring you a product which is truly foremost in quality.

ELECTRA MOTORS, INC.

Anaheim, California

Please send latest information on ELECTRA-GEARMOTORS, *right angle type, as featured above for ratings from ¼ hp to 5 hp.*

NAME_____

FIRM_____

ADDRESS_____

CITY_____ ZONE____ STATE_____

P.S. I am also interested in OTHER ELECTRA PRODUCTS P-1

ELECTRA-GEARMOTORS
Parallel Shaft
½ to 30 hp

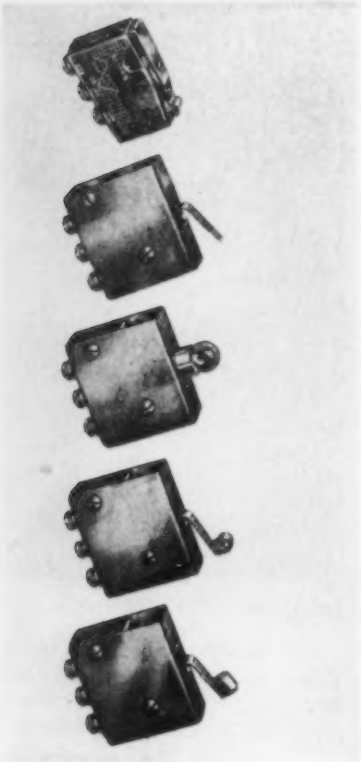
ELECTRA-GEAREDUCERS
Right Angle
¼ to 5 hp

ELECTRA-MOTORS
½ to 75 hp

ELECTRA-GEARMOTORS
Shaft Mounted
¼ to 5 hp

Instrument operates from 115 v, 60 or 400 cps line, and is available in zero center or zero left models. It consists of a standard 4 in. meter with a housing extending approximately 3 in. from the rear. Trio Laboratories, Inc. Seaford, N. Y.

For more information—
Circle 83, inside back cover



Sealed Sine Switch

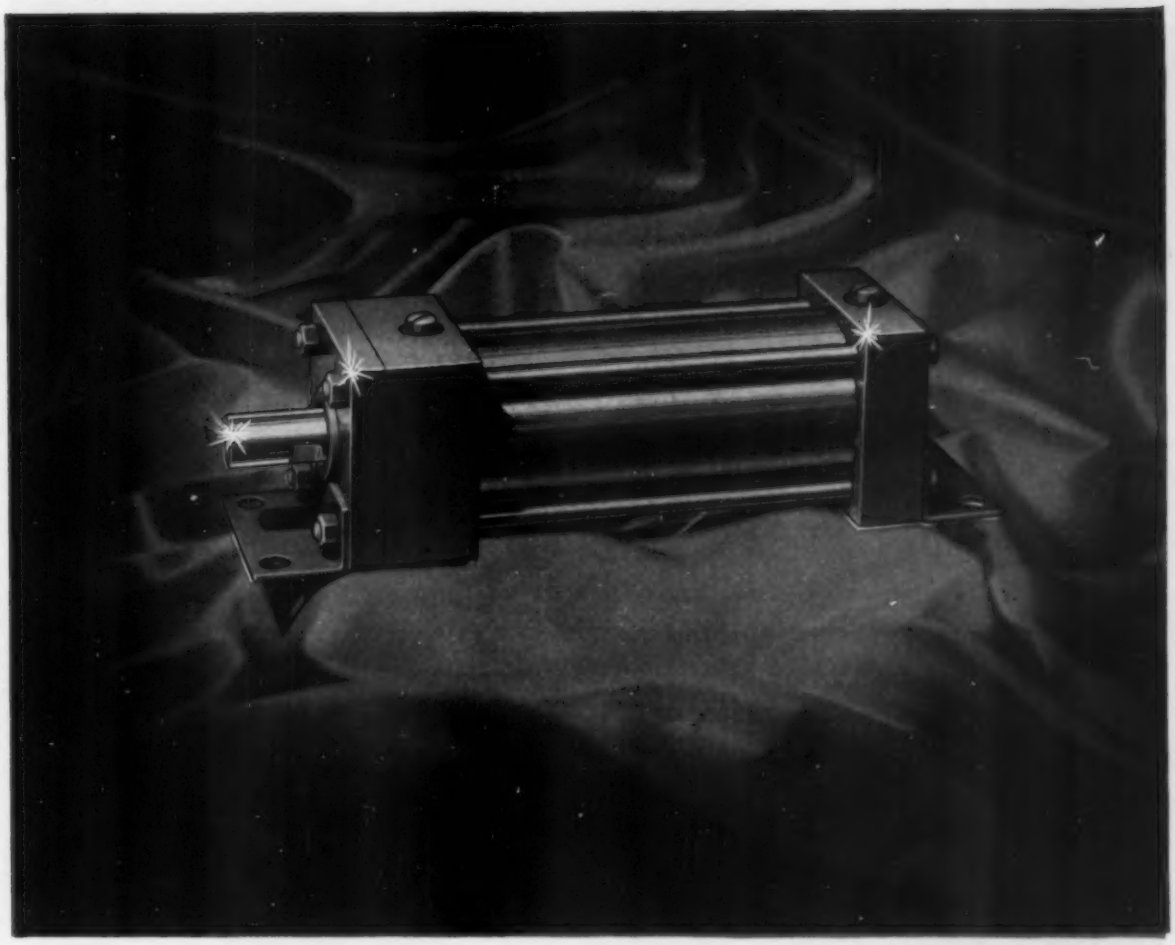
The sealed sine switch, the basic type for these actuating units, has current ratings of 10 amp, resistive, 115 v a-c, 30 v d-c. The unit is a precision snap-action limit switch designed for use in aircraft, guided missiles, industrial controls, and other applications requiring complete operational freedom from all environmental conditions. Spencer Thermostat Div., Metals & Controls Corp., Attleboro, Mass.

For more information—
Circle 84, inside back cover

Voltage Control for 400 Cps

The unit operates on 115 v, 400 cps, single-phase, and provides a continuously adjustable output from 0 to

(Continued on page 288)



Illustrated—Logansquare Cylinder Meets J.I.C. Standards

Look to Logan

the ultimate in air cylinder design

FREE SEND FOR THE "LOGAN CALCULATOR"
A gift to you from Logansport Machine Company upon request.

MEMBER: Natl. Mach. Tool Builders' Assn.; Natl. Fluid Power Assn.

LOGANSPORT MACHINE CO., INC.
812 CENTER AVENUE, LOGANSPORT, INDIANA

PLEASE SEND COPY OF CATALOG:

- ☐ 100-1 AIR CYLINDERS
- ☐ 100-2 MILL-TYPE AIR CYLS.
- ☐ 100-3 AIR-DRAULIC CYLS.
- ☐ 100-4 AIR VALVES
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- ☐ 51 PRESSES
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- ☐ 62 SURE-FLOW PUMPS
- ☐ 200-1 HYD. POWER UNITS
- ☐ 200-2 ROTOCAST HYD. CYLINDERS
- ☐ 200-3 750 SERIES HYD. CYLINDERS
- ☐ 200-4 and 200-7 HYD. VALVES
- ☐ 200-6 SUPER-MATIC CYLS.
- ☐ 70-1 CHUCKS
- ☐ ABC BOOKLET
- ☐ CIRCUIT RIDER

TO:

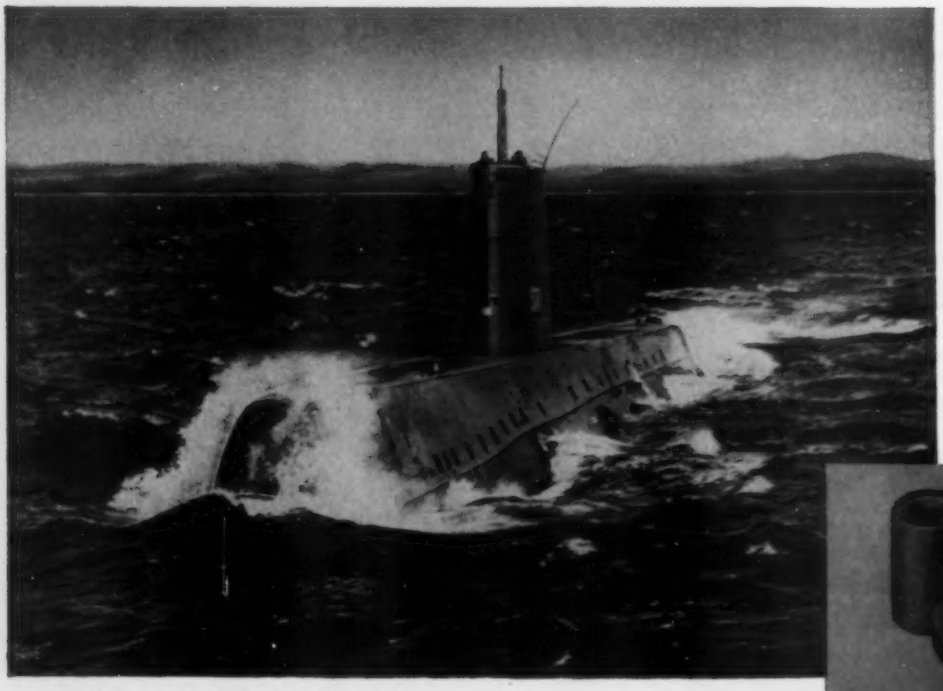
NAME_____ TITLE_____

COMPANY _____

ADDRESS _____

Are your seals or bearings subject to difficult operating conditions?

GRAPHITAR® (Carbon Graphite) has the specific properties needed in difficult applications like these . . .

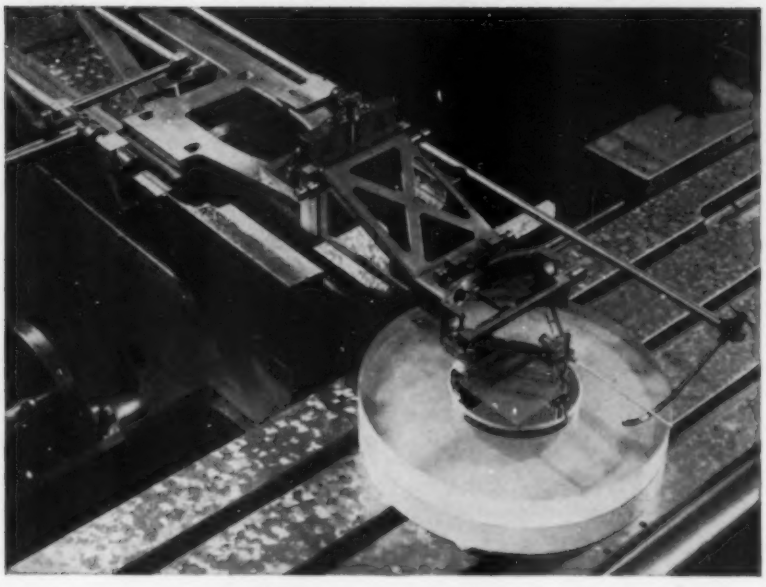


THE MOST IMPORTANT BEARING

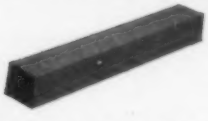
Dependability is vital in the power plant of the Navy's atomic submarine U.S.S. Nautilus which has steamed a total of about 50,000 miles of which approximately half has been submerged. In the reactor cooling system of the submarine, special "canned" motor pumps with integrated pump and drive motor were developed by Westinghouse. The bearings in these pumps, which are made of GRAPHITAR, must withstand high speeds, high temperatures, high pressures and must operate for indefinite periods of time without maintenance and with radioactive water as the only lubricant. Westinghouse Electric Corporation engineers—the builders of the Nautilus' atomic power-plant—find that GRAPHITAR is excellent for this difficult bearing application, because of its strength, durability, self-lubricating properties, and chemical inertness. If your design calls for superior bearings, consider the material that worked on such a demanding job.

THE UNITED STATES

GRAPHITAR® CARBON-GRAPHITE • GRAMIX® SINTERED METAL PARTS • MEXICAN® GRAPHITE PRODUCTS • USG® BRUSHES

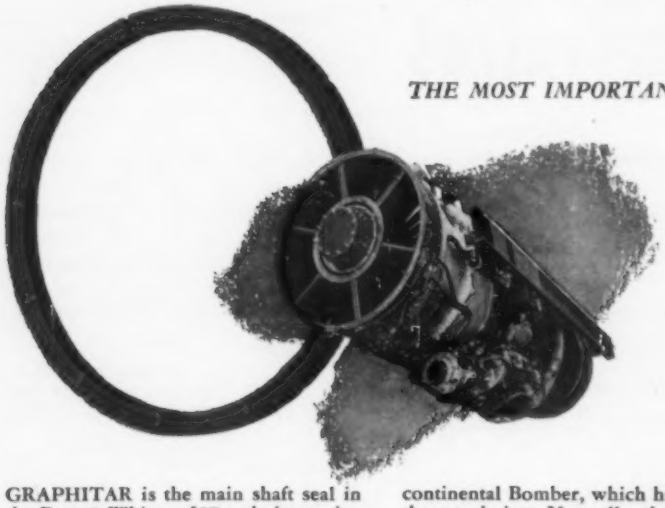


THE MOST EXACTING BEARING



The Bausch & Lomb Optical Co. of Rochester, N.Y., world renowned manufacturer of precision, scientific optical instruments, employs 10 GRAPHITAR bearings in its unique and highly specialized "ruling engine." The GRAPHITAR bearings provide dimensional stability within one-millionth of an inch for micro-inch accuracy in cutting 15,000-30,000 equidistant lines to the inch on 7" aluminized glass blanks to make diffraction gratings used by science and industry for spectroscopic analysis. Bausch & Lomb engineers have found that GRAPHITAR is unsurpassed as a bearing material where very close tolerances must be maintained and where frequent starting and stopping under heavy loads is a problem. These bearings have contributed greatly to the achievement of extreme accuracy in this application. If you require precision performance as was the case with a "ruling engine" why not use GRAPHITAR?

THE MOST IMPORTANT SEAL



GRAPHITAR is the main shaft seal in the Pratt & Whitney J57 turbojet engine which powers many of our new aircraft, including the huge Boeing B-52 Intercontinental Bomber, which has eight of these turbojets. Naturally, the J57 must perform with utter dependability. One of the components of the J57 is the air/oil seal of GRAPHITAR on the turbine main shaft, and this seal is subjected to tremendous shaft speeds, as well as other taxing physical conditions. GRAPHITAR parts can stand severe operation because they are strong and are virtually unaffected by extremes of speed, pressure, and temperature. If your product develops high speeds or other difficult physical stresses on its parts, perhaps GRAPHITAR components could give it more dependable operation.

THE TOUGHEST APPLICATION

Steel mills are famous for the rough, tough, heavy-duty jobs that they perform. In such difficult steel mill applications as bearings for shear and cut-off tables or coil and slab conveyors, metal-backed GRAPHITAR parts provide exceptional strength and durability. GRAPHITAR alone is a very strong bearing material, and when backed with metal has added resistance to shock. Because of its very low coefficient of friction, GRAPHITAR can operate under heavy loads at high speeds with no lubrication. Can the strength and superb bearing qualities of GRAPHITAR simplify your product design?

Get your copy of Engineering Bulletin No. 20.

GRAPHITAR is compacted from carbon-graphite powders under great pressures, then furnaced at heats near 4500°F. It can be formed in relatively complex shapes and ground to tolerances as close as .0005". For more information on this strong, light, self-lubricating engineering material, write for our Engineering Bulletin No. 20.

218-4

GRAPHITE COMPANY

DIVISION OF THE WICKES CORPORATION, SAGINAW, MICHIGAN

spot-welded seams are water, moisture and dust tight when sealed with . . .

PRESSTITE MASTIC SEALERS

Here are the cold facts about Presstite cold-applied Mastic Sealer No. 525:

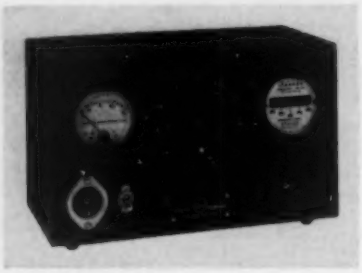
- Specially designed for sealing spot-welded seams and joints to sides and bottom of refrigerator cabinet —as shown in the application above.
- Easily applied directly with heavy-duty pump.
- Lasting adhesion and plasticity on all types of materials.
- Non-corrosive, free from objectionable odor.

WRITE for a working sample and technical data. No obligation.

Manufacturers of Sealing Compounds Exclusively Since 1924

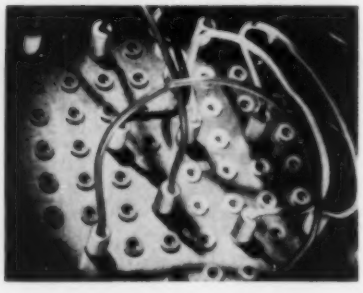
PRESSTITE SEALING COMPOUNDS — PRESSTITE-KEYSTONE ENGINEERING PRODUCTS COMPANY — KAP

A Division of AMERICAN-MARIETTA COMPANY
3750 CHOUTEAU AVENUE, ST. LOUIS 10, MISSOURI



115 v under a maximum load current of 15 amp. Standard instrumentation includes a 3½-in., 21-reed, ½ per cent accurate frequency meter and a 2 per cent accurate a-c voltmeter. Ventilated enclosure is 12x6x7 in. high. Opad Electric Co., 69 Murray St., New York 7, N. Y.

For more information—
Circle 85, inside back cover



Insulated Jacks For Metal Panels

Individually-insulated jacks press-fit into metal sheeting by means of a simple insertion tool. Many holes may be punched at one time in contrast to individually drilled holes. Intended for standard 0.080 in. test prod or comparable plug, the jack holds firmly for any prod diameter from 0.077 to 0.083 in. Jacks and plugs may be had in eight standard RETMA code colors. Sealectro Corp., 610 Fayette Ave., Mamaroneck, N. Y.

For more information—
Circle 86, inside back cover

Miniature Switch With 360 Deg

Hermetically sealed, the switch has a rotary action with 180 deg pre-travel 180 deg over-travel. Available with potted leads or pin connectors. It measures 2x1¾x1 in.

The switch operates at 28 v d-c or

(Continued on page 292)

more

Locking Power

...than any other washer or washer substitute

SHAKEPROOF®
Lock Washers

Shakeproof locking teeth can be incorporated into many types of lock washers . . . for added strength, countersunk, and elongated holes, heavy-duty applications and other requirements.

- Shakeproof Lock Washers assure maximum vibration protection for your product
- Exclusive tapered-twisted teeth resist loosening • Assure maximum locking engagement • Form positive brace against rotation • Resist shock
- Available in nearly 500 job-tailored styles and wide size range.

Send for Shakeproof Lock Washer Sample Kit

SHAKEPROOF

"FASTENING HEADQUARTERS"®

DIVISION OF ILLINOIS TOOL WORKS

St. Charles Road, Elgin Illinois • Offices In Principal Cities
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itw

MUELLER BRASS CO. 600 SERIES BRONZE

the main working part in the smooth and OCEAN CITY SPINNING REELS

600 Series gears prove ideal in heavy duty salt water models 300, R300, and 320 in which corrosion resistance and high strength are important.

Other typical "600" applications

FORGED GEAR powerful

The Montague-Ocean City Rod & Reel Co. of Philadelphia is proud of the fact that many fishermen are calling their famous Ocean City "300" series spinning reels "the most dependable spinning reels in America." Such praise justifies the very best components in a product—like the corrosion-resistant Mueller Brass Co. "600" alloy gear. Provides its own shaft and has an integral clutch which takes the driving force from the handle, and incorporates a cam which provides the oscillating motion of the spool for cross-winding the line. Bronze was chosen because of the need for maximum strength, long wear, and because it is such an excellent bearing material. This application dramatically points up the valuable properties of Mueller "600" series alloys.

There are countless applications of Mueller "600" series bearing alloys. Find out how you can utilize one or more of them in YOUR products. Because forgings can be made closer to the finish size in "600" series alloys than can sand castings, there is less waste, greater speed in finishing.

• WRITE TODAY FOR THE ENGINEERING MANUAL YOU NEED

Mueller Brass Co. Forgings
Engineering Manual H-58565 ☐

Tuf Stuf Aluminum Bronze Alloys
Engineering Manual H-58563 ☐

600 Series Bearing Alloys
Engineering Manual FM-3000 ☐

Copper Base Alloys in Rod Form
Engineering Manual FM-3010 ☐

METALS AND ALLOY REVIEW

by **FRANK M. LEVY**

Vice-President and Director of Research

Recently Ray Engelgau, who heads our statistical quality control procedures, and Amos Armitage from our machining department met in my office and we had a very interesting discussion on our new "S-C" rod. The term "S-C" is derived from the fact that it is produced from billets that are cast semi-continuously. In addition, we use the letters "S-C" to indicate its "super cutting" qualities which is one of the outstanding characteristics of this rod. We have definitely proved these qualities in some very exhaustive tests, one of which I'd like to tell you about here.

Experience has shown that it is difficult to control dimensions within close tolerances on machine parts involving internal forming operations. Amos had run into exactly that trouble with a certain hydraulic fitting made from rod that required a fairly close dimensional tolerance on the internal formed diameter. So, we decided to make a comparison test by machining the part from rod made by the conventional method and from rod produced by the S-C process. When rod made by the conventional method was machined, the parts could not be held within the specified tolerance range. The same machine, the same tooling and the same machine operator were used in this test, and when S-C process rod was substituted, the machine parts were well within the required tolerance range.

In addition, I just received a letter from a well-known equipment manufacturer who has been running tests on S-C rod. They reported that the incidence of tool trouble per 1000 forgings machined from S-C rod were approximately half that of forgings made from conventional rod. We think that is pretty good evidence that the rod made by our semi-continuous process is exceptionally uniform by all standards. Incidentally, our new billet casting department is quite a model of automation and has a number of interesting processes and features. Anytime you happen to be in our area we would be more than happy to show you through and explain the many points of this process that gives us what we firmly believe to be the best possible rod available today which of course is reflected in the quality of our forgings.

If you would like a folder that fully covers our semi-continuous process, just drop me a note and I'll see that one is sent along to you promptly. In the meantime, we'd like to have you investigate our super-cutting S-C rod because we think it will improve your product quality—and we've got the alloys to do most anything to meet the most exacting demands.

Thanks for your time.

MUELLER BRASS CO.

PORT HURON 22, MICHIGAN

POSSIBILITIES UNLIMITED

bring yourself up-to-date on

INDIUM

...and what it can do for you

QUALITY

at the Indium Corp. of America means: purity of metals, and strict adherence to specifications.

SERVICE

means prompt delivery to customers, and technical help in specific uses of Indium.

RESEARCH

means "forward looking" with respect to new products and techniques.

WRITE TODAY

for new Indium bulletin . . . "Nomographic Charts of Pellets and Spheres — Weights per Thousand in Grams."

INDIUM . . . the metal of unlimited possibilities . . . is the "element of success" in many startling engineering achievements.
Its unique stabilization properties have made possible revolutionary metallurgical advances in the electronics and aircraft fields.

INDIUM may have significant applications in your own product development!
Why not discuss your problems with us?

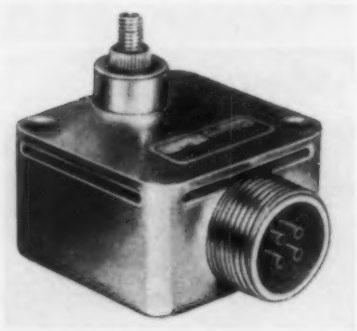
AVAILABLE IN COMMERCIAL QUANTITIES

• Indium metal (specially refined 99.999% pure) • Indium metal (99.97+% pure) • Indium wire • Indium foil and ribbon • Intermediate "indalloy" solders • Indium pellets • Indium spheres • Indium powders

The INDIUM *Corporation of America*

1676 Lincoln Avenue — Utica, New York

SINCE 1934...PIONEERS IN THE DEVELOPMENT AND APPLICATIONS OF INDIUM FOR INDUSTRY



110 v d-c with a 10 amp resistive rating, 4 amp inductive. At 110 v a-c (60 to 400 cps or 220 v) the resistive rating is 10 amp. Haydon Switch, Inc., Waterbury 20, Conn.

For more information— Circle 87, inside back cover

High-Speed Switching Transistors

These PNP transistors are of the germanium alloy type intended primarily for high-speed, high-current switching. A typical switching speed is 0.3 microsec at 400 milliamp of collector current. The series resistance when conducting is ½ ohm; the nonconducting series resistance is as high as 10 megohm. General Transistor Corp., 91-27 138 Pl., Jamica, N. Y.

For more information— Circle 88, inside back cover

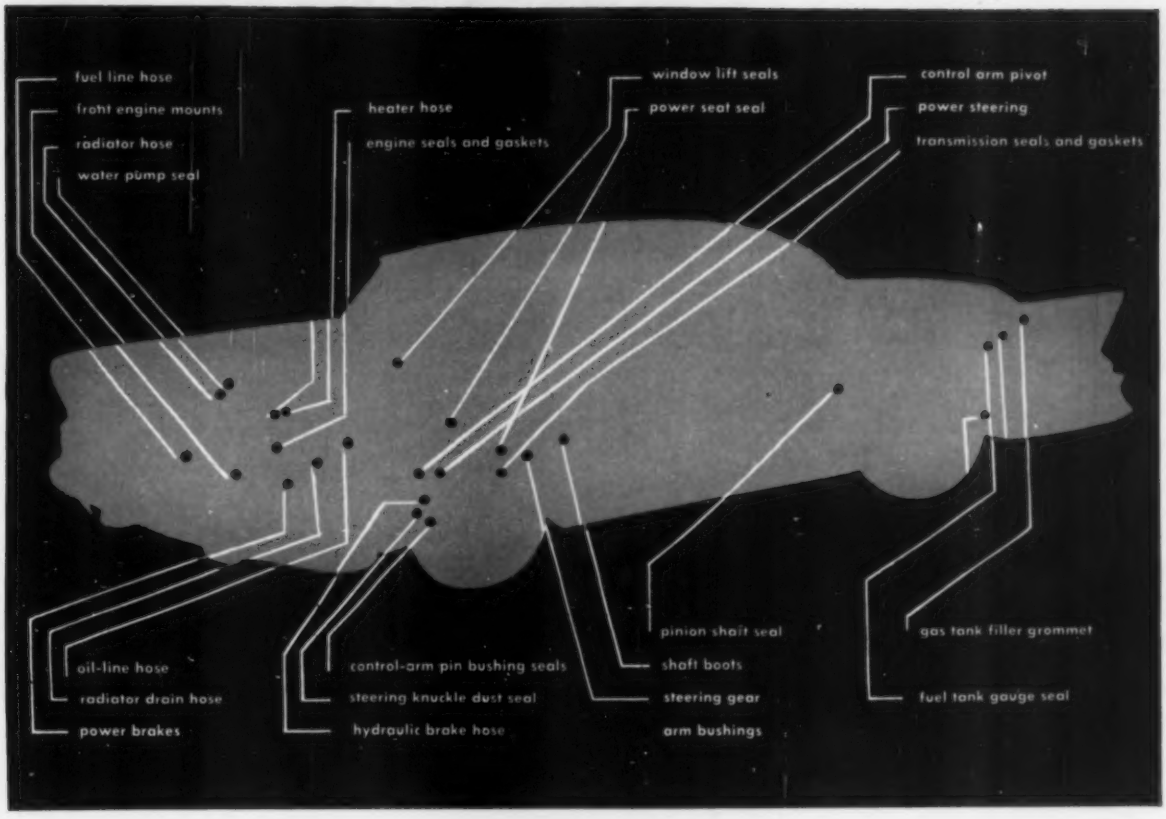
Locally Mounted Temperature Control

This is a dual switch control that can often substitute for two separate single-switch controls. The immersion element (bellows housing) is placed directly into the medium that is to be controlled. Variations in the temperature of the medium are converted to a force that causes the bellows plunger to operate the two switches.

The control head is enclosed by a cast aluminum case. It has an external range adjustment with a cali-

(Continued on page 297)

Naugatuck Paracril



Paracril...the oil-resistant, nitrile rubber suited to many automotive applications!

Spelled-out above are just a few applications for Paracril, Naugatuck's butadiene-acrylonitrile copolymer. Unequalled in resistance to oils, fuels and organic esters, aromatic hydrocarbons, chlorinated organic liquids and most hydraulic fluids, the Paracrils provide greater tensile strength with increased dimensional stability, high abrasive resistance, unusual low-temperature flexibility, and excellent resistance to oxidation.

Paracril® stocks are fully compatible with most other rubbers and plastic resins... can be calendered, extruded, or molded by standard rubber forming methods... are easily dissolved in solvents to make low-viscosity solutions for cement applications.

Why not write to us on your company letterhead for application and test data today?

Naugatuck Chemical

Division of United States Rubber Company
Naugatuck, Connecticut

US RUBBER

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GENERAL CONTROLS

REDUCES Operating Time **REDUCES** Bench Size **REDUCES** Manpower Cost

Two years of perfect performance prove how General Controls solenoid valves and pressure regulators provide low cost... reliable pneumatic test bench set-up

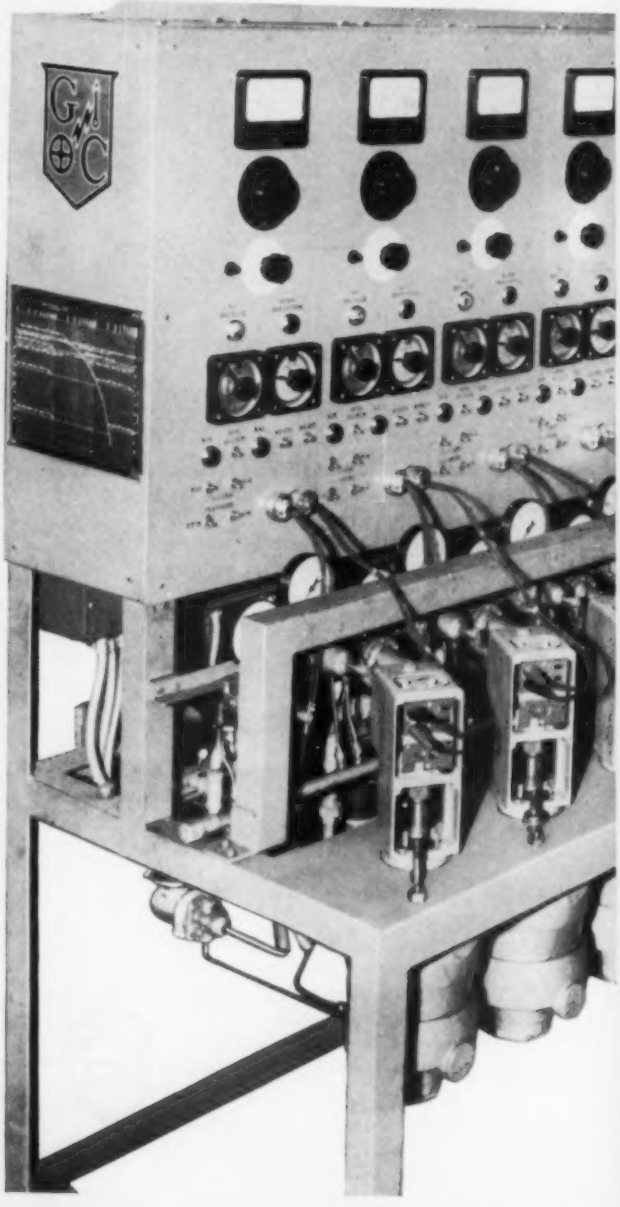
PROBLEM: To speed production output and increase economy, test engineer needed rugged, reliable pneumatic test set-up to vary pressure, provide selective load... simple controls, easy-to-read dials for one bench man to operate... up to 10 stations.

SOLUTION: Test engineer called in General Controls field representative who quickly devised a simple combination. A total of 40 two-way and three-way large capacity solenoid valves carry the load, and 20 pressure regulators with easy-to-read scales control the air flow.

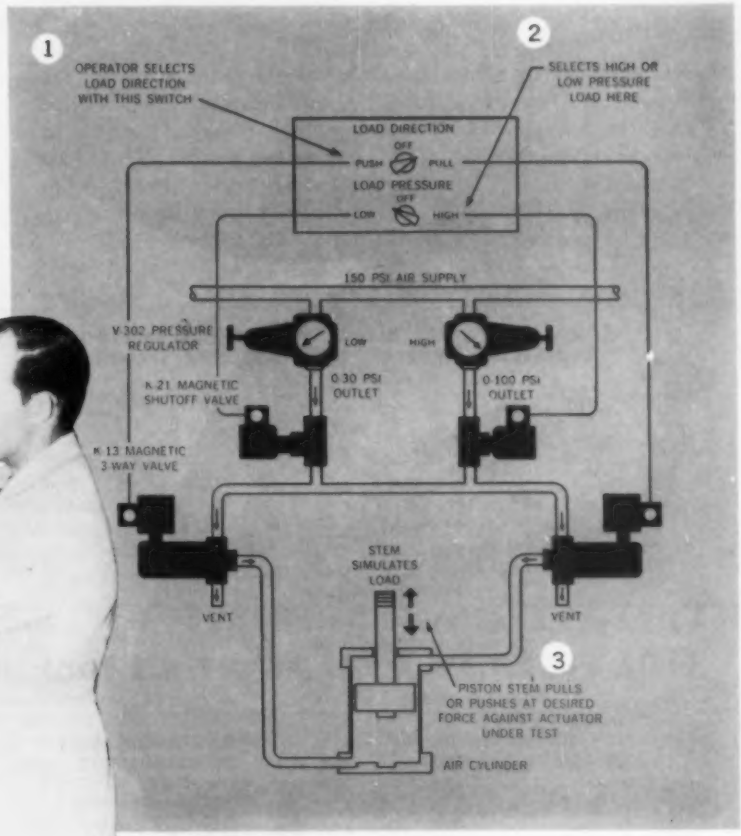
RESULT: Test bench has been operating on a heavy production schedule *for over two years without a failure!* No maintenance... lower labor cost... and increased output spell real economy!

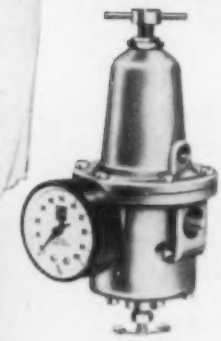
NEXT TIME YOU have a control problem, remember that General Controls specializes in automatic controls that do the *whole* job better, more dependably. General Controls is a single source you can rely on... backed by a factory-trained field organization to provide skilled engineering counsel.

Call your nearby General Controls branch office.
Or write for a complete catalog:
GENERAL CONTROLS,
Dept. 300-U Glendale 1, Calif.



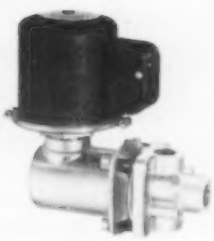
SOLVES TEST BENCH PROBLEM





V-302
Pressure
Regulator

K-21
Solenoid
Shutoff Valve



K-13
Three-way
Solenoid Valve

GENERAL CONTROLS

America's Finest Automatic Controls for Home, Industry, and the Military

Glendale, California · Skokie, Illinois

Five Plants — 40 factory branch offices serving the United States and Canada

Count on CONTINENTAL for the **new cost-saving ideas** in fastener design and application

HOLTITE® NYLOK Screws and Bolts are one of the many progressive ideas in fasteners pioneered by Continental. These one-piece, self-locking fasteners with the Nylon insert eliminate the need for lock washers, jam nuts, wiring, and similar devices. If you have fastening problems (like the applications below), for which Nylok is the practical solution, you can start now to save assembly dollars, and give your product a definite competitive advantage.

BEATS VIBRATION IN COMPRESSOR MOTOR

Hex-head, alloy steel cap screw with Nylok insert. Suggests many similar applications in motor driven units.

PROVIDES SAFETY IN AUTO DOOR STRIKER PLATE

Phillips flat-head steel machine screw with Nylok insert. Keeps doors closed in event of collision, resists vibration.

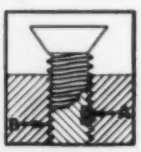
HOLTITE® NYLOK® Self-locking Screws

PREVENTS SCREW "SHEDDING" IN POWER MOWER

Hex-head, alloy steel cap screw with Nylok insert. Holds wheel to drive shaft. Stops screw loss, customer complaints.

HOLDS ADJUSTMENT IN CARBURETOR

Socket head, alloy steel, cone pointed set screw. Resists vibration, heat, and effects of fuel contact.



HERE'S WHY HOLTITE NYLOK® LOCKS SECURELY

Resilient nylon plug (A) sets up a lateral thrust, smoothly wedges mating threads together (B). All locking action is on threads: head is not stressed. Locking is positive . . . seated or unseated.

One piece — no separate parts
Can be removed and replaced
Interchangeable — reusable
Locks seated or unseated
Acts as seal for gases, liquids

CHECK YOUR ASSEMBLIES Find out where Continental cost-saving ideas, like Nylok, can cut your assembly costs. Continental Assembly Specialists are fully qualified to analyze your operations and advise which fasteners — *standard or special* — can save you most. For prompt service, write or phone: Continental Screw Co., 452 Mt. Pleasant St., New Bedford, Mass.

CONTINENTAL

SCREW COMPANY, NEW BEDFORD, MASS.

HOLTITE FASTENERS

PHILLIPS AND SLOTTED HEAD TAPPING SCREWS, WOOD SCREWS, MACHINE SCREWS, SEMS, BOLTS, NUTS STANDARD OR SPECIAL . . . FOR ANY ASSEMBLY

brated scale, and temperature settings are made by rotating a single-turn knob and pointer to the desired point on the scale. Models with range spans of 50 or 100 F, between limits of 30 and 400 F are available. The unit weighs approximately 15 oz. United Electric Controls Co., 79 School St., Watertown, Mass.

For more information—
Circle 89, inside back cover

Plug-In 240-v Circuit Breakers

These two and three-pole breakers, for up to 50-amp circuits, plug into new lines of associated plug-in power panelboards and separate individual enclosures. The three-pole unit has qualified for UL-listing; listing of the two-pole is expected shortly. General Electric Co., Schenectady 5, N. Y.

For more information—
Circle 90, inside back cover

Cast Aluminum Footswitch

Grooved top prevents operator's foot from sliding. The rubberized cork skid pad on the bottom keeps the footswitch in place. With a snap-action switch, the unit is rated 15 amp, 125 v, a-c. The footswitch is available with a standard cordset or with a cordset to customer specifications. A safety guard is also available. The footswitch measures 3¾x3x1¼ in.

(Continued on page 298)

Why wrestle with GEAR PROBLEMS?

Get the right solution from SIER-BATH

Instead of "try this" and "try that" suggestions, Sier-Bath provides the seasoned experience of gear experts who immediately recognize and solve your problem the *first time*. You save time—and get better gears that cost you less.

Sier-Bath customers enjoy the best gear design, engineering and manufacturing service. Many machine manufacturers have moved to leadership in their fields, through the improved operation of Sier-Bath gears.

Send us your gear drawings for study and quotation—or have a Sier-Bath gear specialist call to discuss your gear requirements.

FREE! Valuable 36-Page Gear Manual

This authoritative manual brings you the most advanced gear technology, design data and complete specifications of what to demand in gears. Clearly illustrated with photos, graphs, tables and technical views. Write on company letterhead for your free copy.

Sier-Bath PRECISION GEARS

All kinds of gears—all materials.
Made—cut—shaved—ground tooth.
48" maximum diameter

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9238 HUDSON BOULEVARD NORTH BERGEN, N. J.
Founded 1905 Members A.G.M.A.

Also manufacturers of Rotary Pumps and Flexible Gear Couplings

save more of it

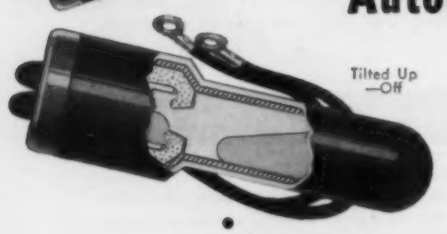
with

STUD WELDING

. . . the fastest electric arc welding process for end welding fasteners

KSM®

KSM PRODUCTS, INC.
stud welding division
MERCHANTVILLE 48, N.J.



DURAKOOL Tilt Switches are the Life of your Automatic Controls

This steel-clad Durakool mercury tilt switch has unique construction features that deliver years of trouble-free performance on the most difficult assignments you can find. Operating under sealed-in, pressurized hydrogen gas, it takes 24 hours, fast cycling schedules in stride. 7 sizes, 1 to 65 amperes. Send for Bulletin 525.

MILLIONS OF CYCLES
WITHOUT FALTERING

See telephone directory for local distributor, or write.
DURAKOOL, INC.
ELKHART, INDIANA, U.S.A.
700 WESTON RD., TORONTO 9, CANADA

Durakool ALL-STEEL MERCURY *Switches*

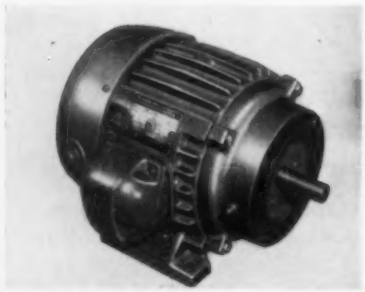
and weighs 10 oz. Vemaline Products Co., P. O. Box 222, Hawthorne, N. J.

For more information—
Circle 91, inside back cover

Variable Control

The control uses a molded composition resistance track and a radial resistance element, filling the entire inner perimeter of the resistor barrel. Standard rating is 3 w. Reon Resistor Corp., 117 Stanley Ave., Yonkers, N. Y.

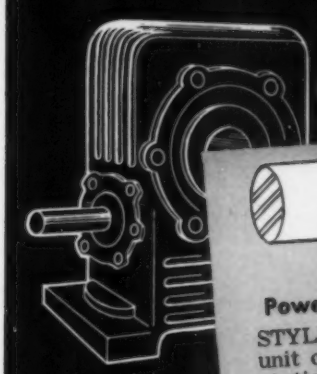
For more information—
Circle 92, inside back cover



Direct-Mounting, Totally-Enclosed Motor

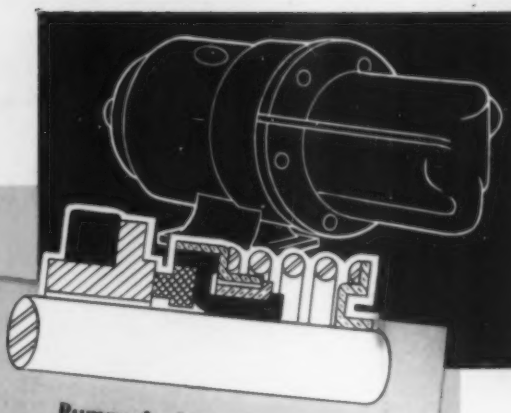
A totally-enclosed motor with facilities for mounting driven equipment directly to the motor is available in

(Continued on page 302)



Machine Tools And Power Transmission Equipment

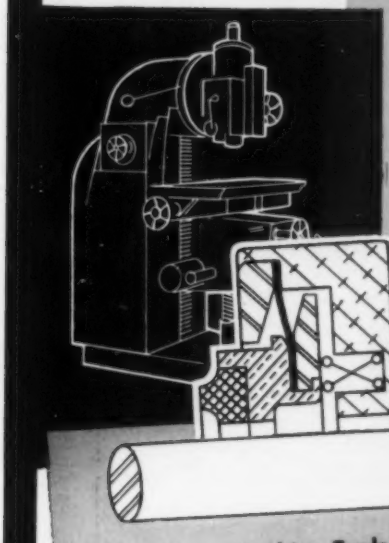
STYLE GU — A packaged sealing unit containing both rotating and stationary seal faces enclosed in metal housing. Stock sizes for shafts .250 through 4.000.



Pumps And Compressors

ROTO-FLEX — Rugged flexibility. Only 3 parts. Single or double units. Stock sizes for shafts .250 through 4.000.

STYLE RFO — A specially designed Roto-flex seal, for installation outside the stuffing box. Stock sizes for shafts .250 through 4.000.



Heavy Machine Tools

STYLE DPC — A high-speed, carbon-faced seal, for more compact installation in heavy industrial machinery. Stock sizes for shafts .250 through 4.000.

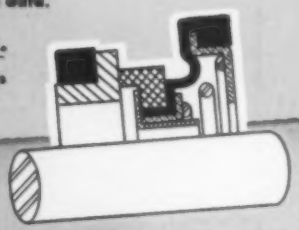
A Complete Line
GITS SHAFT SEALS
For Every Application

These modern, mechanical, face-type seals are carried in stock — to save you time and money. Write for detailed data.

GITS BROS. MFG. CO.

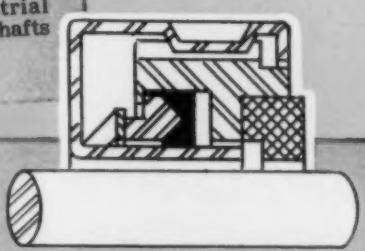
1888 South Kilbourn Avenue • Chicago 23, Illinois

Specialists In Lubricating Devices And Shaft Seals For Almost Half-A-Century



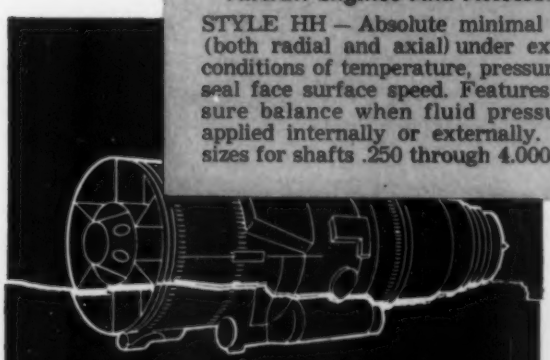
Household Appliances

STYLE SGU—A factory-assembled unit-type seal for the small-budget user. Stock sizes for shafts .250 through 1.000.



Aircraft Engines And Accessories

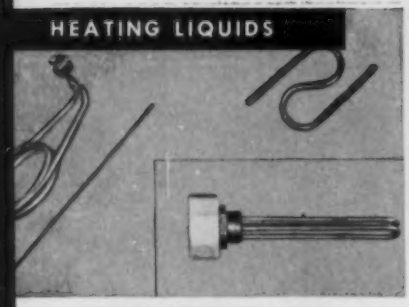
STYLE HH — Absolute minimal space (both radial and axial) under extreme conditions of temperature, pressure and seal face surface speed. Features pressure balance when fluid pressure is applied internally or externally. Stock sizes for shafts .250 through 4.000.



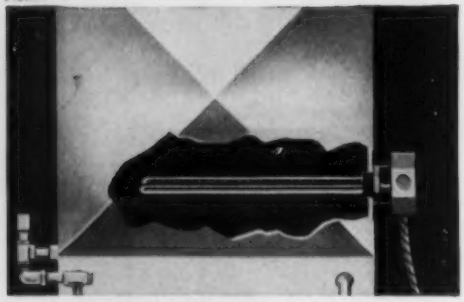
DESIGNING HEAT INTO YOUR PRODUCT?

General Electric Metal-sheath Heaters Save Time in Both Production and Design

HEATING LIQUIDS



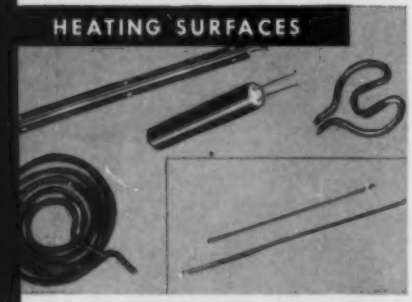
1 **DISHWASHER MAKER CHOSE** screw-in type G-E immersion heater from wide variety available. Threaded fitting speeds installation.



2 **DIRECT CONTACT WITH LIQUID** over entire heating surface provides fast heat-up and minimizes heat-transfer losses. Thermostat is easily installed for temperature control.

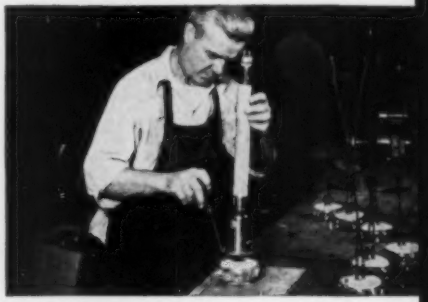
3 **SIMPLE ELECTRICAL CONNECTIONS,** after heater is screwed into place, complete installation. Assembly is fast, easy.

HEATING SURFACES



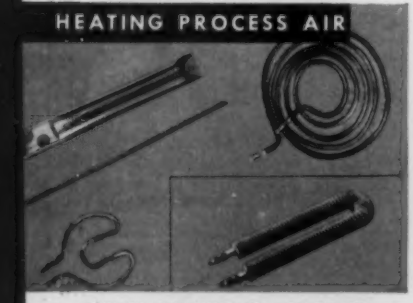
1 **EASILY FORMED WITHOUT BREAKING . . .** this is reason why General Electric tubular heaters are choice of branding-iron manufacturer.

2 **STURDY METAL SHEATH** permits casting heaters right into die body—without production headaches. Result is dependable, even heating of entire die surface.

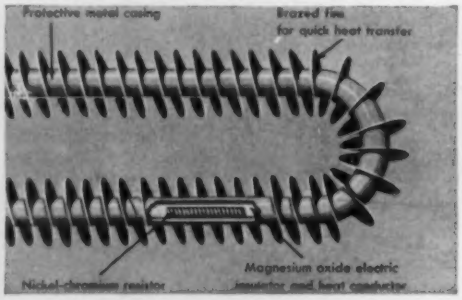


3 **LONG LIFE** comes from combining quality die work with dependable G-E heaters. Users report up to 12 years life.

HEATING PROCESS AIR



1 **LARGE RADIATING SURFACE** per unit length of G-E finned tubular heaters allows maximum air circulation in forced-convection heating.


Protective metal casing
Brazed fins for quick heat transfer
Magnesium oxide electric insulator and heat conductor
Nickel-chromium resistor

2 **COMPLETELY ENCLOSED** heating element of General Electric finned heaters is protected from dust in the air stream, eliminating trouble from short circuits.

3 **PRE-FORMING TO YOUR SPECS** reduces on-site fabrication time and costs, and helps solve problems of installation.

HANDY SELECTOR GUIDES . . .

Learn how to pick the right G-E heater for your job.

NAME .....

COMPANY .....

ADDRESS .....

CITY ..... STATE .....

Mail to Section P723-11, General Electric Company, Schenectady 5, N. Y.

- ☐ **GEA-6113 Handy Selector Guide for Metal Melting**
- ☐ **GEA-6146 Handy Selector Guide for Surface Heating**
- ☐ **GEA-6305 Handy Selector Guide for Water, Alkaline or Plating Baths**
- ☐ **GEA-6306 Handy Selector Guide for Heating Oil**
- ☐ **1957 Catalog of Heaters and Devices**

For more information, contact your local G-E Apparatus Sales Office

GENERAL ELECTRIC

HANNA CYLINDERS

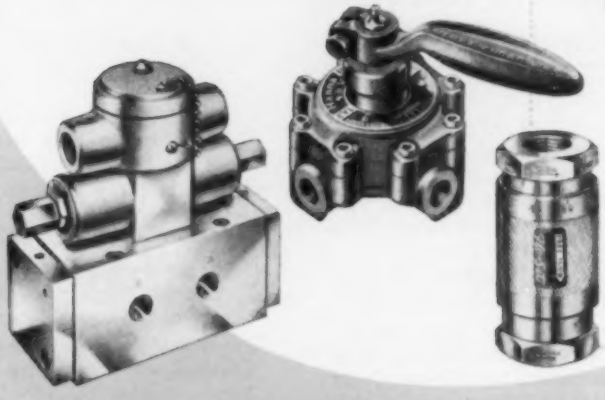
There is a complete line of Hanna Cylinders to suit all requirements of size and mounting . . . in capacities up to 250 psi for low pressure air or hydraulic operation, and up to 1500 psi hydraulic.

. . . finest combination

for Dependable Fluid Power

and Reliable Controls

HANNA VALVES



Designed to assure most efficient control, there are many types and sizes of Hanna Valves available for hand, foot and electric operation, for automatic, remote and speed controls.

It may not take over half a century to design and build a superior line of cylinders and valves . . . but the experience a company compounds in that time surely helps. Hanna has that background.

What does it mean to You, today—in terms of cylinders and control valves? — Basically these important things:

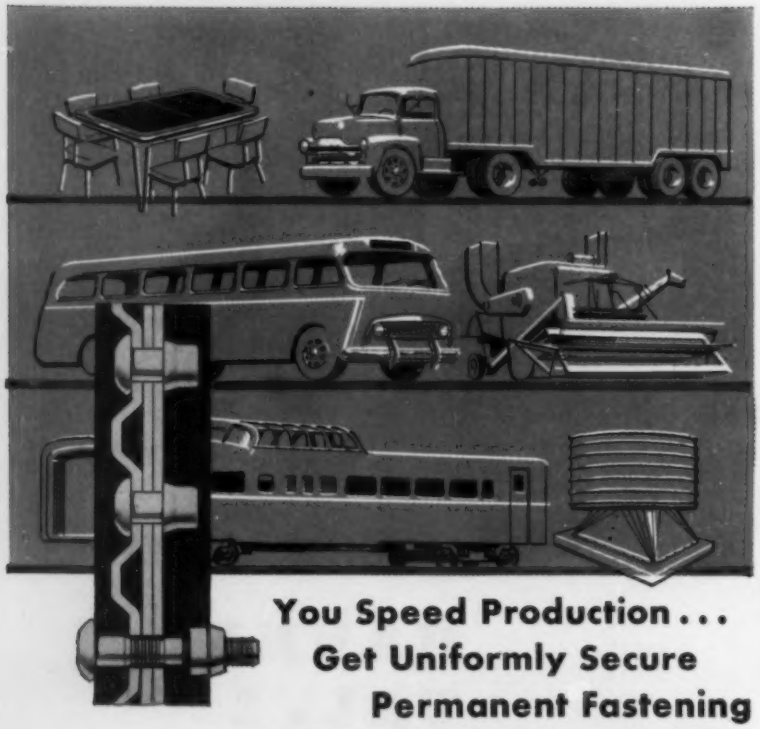
- Products designed and manufactured to the very highest standards of performance . . . not built down to a price—although they are competitive.
- A line so complete that you can specify a "standard" Hanna cylinder or valve to suit your "special" jobs.
- A plant engineering staff that backs a nation-wide regional engineering-sales organization to help you quickly solve difficult problems—and to follow through on all your "needed now" requirements. Many Hanna Representatives stock the standard sizes and types of Hanna Products—the Hanna Plant, of course, does, too.

Whether you need cylinders and controls for equipment that is for resale, or for your own plant use . . . call or write your Hanna Representative (see classified telephone directory or Thomas' Register) or write us direct.

Hanna Engineering Works

HYDRAULIC AND PNEUMATIC EQUIPMENT . . . CYLINDERS . . . VALVES

1763 Elston Avenue, Chicago 22, Illinois



You Speed Production . . . Get Uniformly Secure Permanent Fastening With Townsend Lockbolts

The Townsend lockbolt provides a quick method of producing uniformly secure fastenings that cannot loosen even under extreme vibration or shock conditions. They combine the advantages of riveting and bolting—eliminate the disadvantages.

Typical users are manufacturers of railroad cars, highway trucks and trailers, buses, farm equipment, industrial ventilators, and furniture. They find that the use of Townsend lockbolts gives them an opportunity to improve their products—reduce unit costs.

These benefits are possible for several reasons. By use of Townsend lockbolts, fewer and less skilled workers can complete an assembly faster than by other methods because the setting action does not depend upon the skill of the operator. The clamping action, or tensile preload is higher than rivets—is more uniform than bolts and nuts. The lockbolt makes possible a more rigid joint because it fills the hole better than other fasteners.

Townsend lockbolts are available in steel and aluminum alloy, in 3/16", 1/4", 5/16", 3/8" and 1/2" diameters, in grip lengths ranging up to 2" in various head styles. Other material and lengths available upon request. They are described in Sweet's design file and in Townsend bulletin TL-101.

For a demonstration at your desk of how to get better, economical fastening with Townsend lockbolts, write on your company letterhead to Townsend Company, P. O. Box 237-D, New Brighton, Pa.

Licensed under Huck patent nos. RE 22,792; 2,114,493; 2,527,307; 2,531,048; 2,531,049; 2,754,703

THE FASTENING AUTHORITY

Townsend

COMPANY • ESTABLISHED 1816

NEW BRIGHTON, PENNSYLVANIA

Sales Offices in Principal Cities

Cherry Rivet Division • Santa Ana, California

ratings of 1 to 30 hp. A brass slinger prevents moisture from entering at the take-off shaft. Castings are normalized to prevent misalignment of bearings. Old grease is purged during re-lubrication, without disassembly of the motor or removal of the fan guard. U. S. Electrical Motors Inc., Box 2058, Terminal Annex, Los Angeles 54, Calif.

For more information—
Circle 93, inside back cover

A-c or D-c Counters

These counters, available with either four or five digits, have a manual push-button zero reset arrangement and can be supplied for a-c or d-c. They can register up to 25 impulses per second.

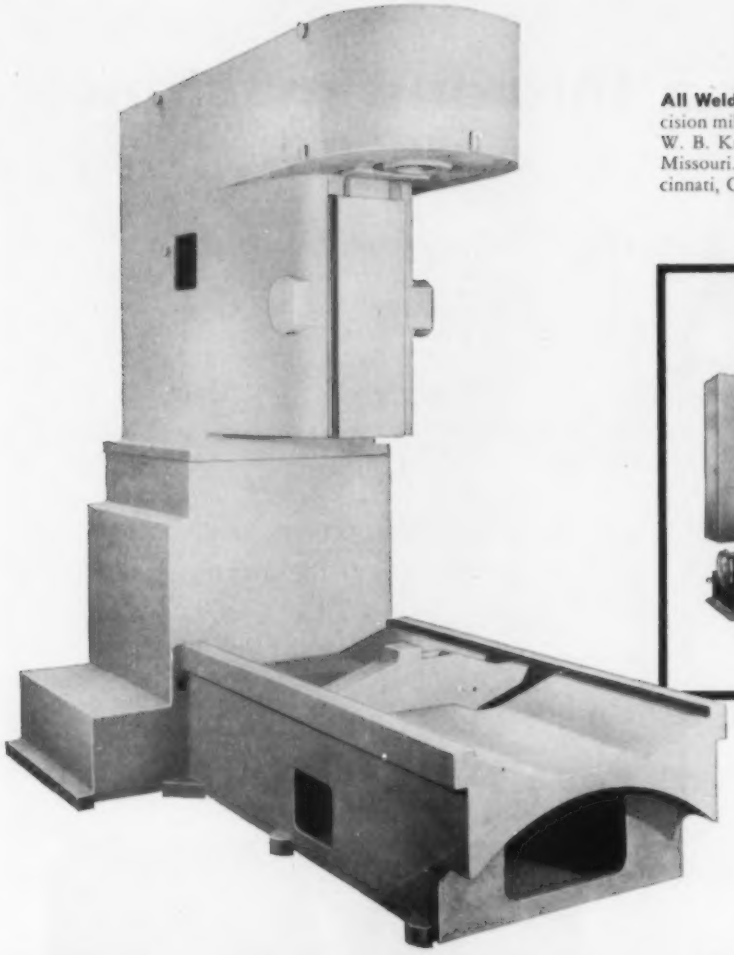
These counters are designed for flush panel mounting and are supplied with protective housing. Dimensions are: for four-digit models, 2 7/8 x 1 3/8 x 1 3/4 in.; five-digit, 2 7/8 x 1 5/8 x 1 3/4 in. Standard voltages are from 4 to 220 v. Landis & Gyr, Inc., 45 W. 45 St., New York 36, N. Y.

For more information—
Circle 94, inside back cover

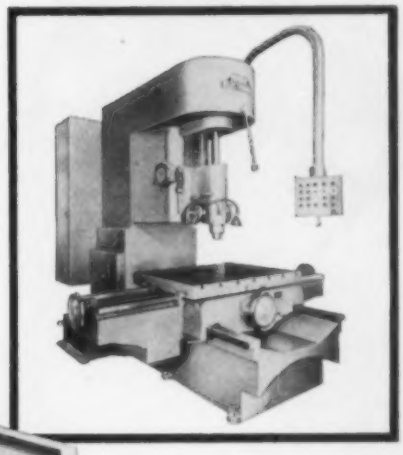
Digital Voltmeter

This miniature d-c digital voltmeter weighs 25 lb and measures 7x10x13

(Continued on page 306)



All Welded Steel Base and Column for precision milling and boring machine. Designed by W. B. Knight Machinery Company, St. Louis, Missouri. Fabricated by Littleford Brothers, Cincinnati, Ohio.



MORE RIGID TO HOLD CLOSER ALIGNMENT

... Welded steel design makes it possible at lower cost

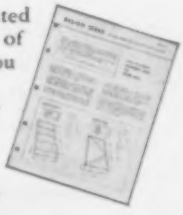
BY proper use of welded steel construction, many types of machines can be built to hold closer alignment and maintain higher tolerances. This is possible because steel is 2½ times as rigid as iron.

Because steel designs use less material, and because steel costs only a third as much per pound as iron, costs can be lowered substantially.

On these precision machines, rigidity for close alignment is combined with modern appearance. Additional savings in cost are possible since patterns and castings are eliminated.

Benefits like these could be duplicated in your designs. Lincoln's 45 years of cost-cutting experience can show you how.

Designers and engineers write for bulletins on designing for steel.



THE LINCOLN ELECTRIC COMPANY

Dept. 1320, Cleveland 17, Ohio

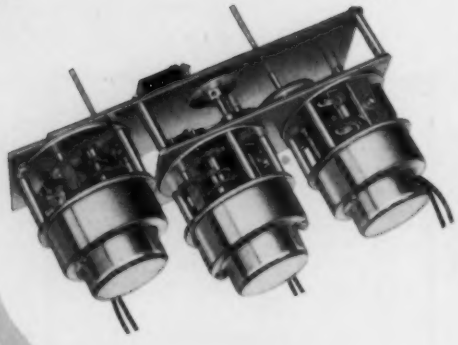
When steel is three times stronger than iron

Has 2½ times the rigidity

Yet costs ⅓ as much

WHY
aren't all your products designed for welded steel

"BRAINS" for a thinking machine!



BRISTOL MOTORS

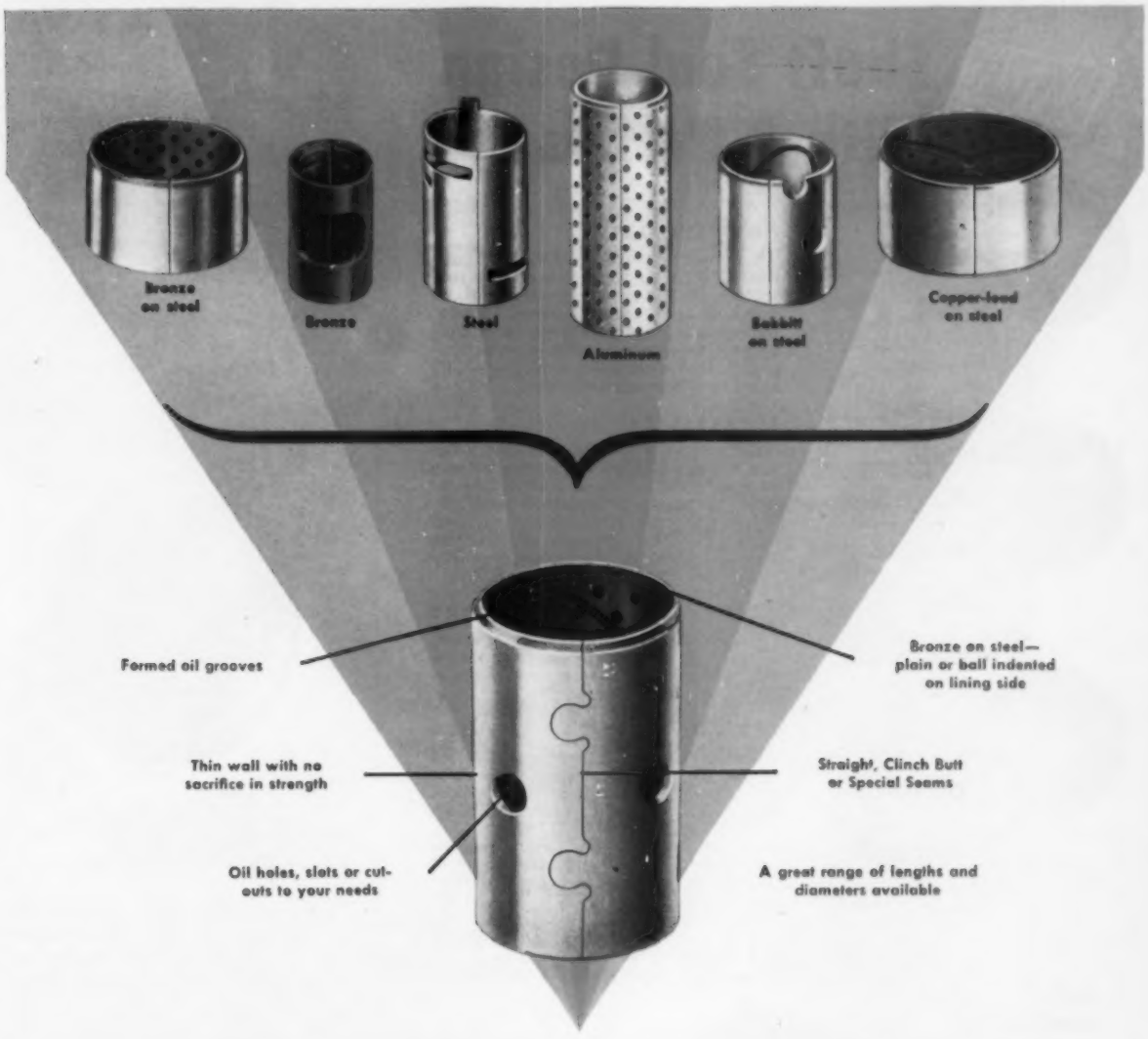
Supplies highly accurate synchronous timing devices for the amazing new

QUARIE OPTIMAL CONTROLLER

Once again Bristol Engineers have solved an intricate timing problem. That's their business. The highly specialized timing device custom-designed for Quarie uses standard Bristol Motor units. Result: highest-quality performance *plus* bed-rock economy!

The Quarie Optimal Controller offers amazing new advantages. It automatically balances the many variable factors — often unpredictable and immeasurable — involved in a process, and concludes the best compromise for licking the specific problem. But when your problem is *timing* — call Bristol *first*.
Write today . . .

BRISTOL MOTOR DIVISION
VOCALINE COMPANY OF AMERICA, INC.
107 COULTER STREET, OLD SAYBROOK, CONNECTICUT


Bronze on steel
Bronze
Steel
Aluminum
Babbitt on steel
Copper-lead on steel
Formed oil grooves
Bronze on steel—plain or ball indented on lining side
Thin wall with no sacrifice in strength
Straight, Clinch Butt or Special Seams
Oil holes, slots or cut-outs to your needs
A great range of lengths and diameters available

Bearing Performance with Bushing Economy

Any of these design features can be incorporated in our plain or bi-metal bushings. For many applications lower cost bushings provide the needed bearing characteristics at a distinct price advantage. We provide a complete engineering service. Address:

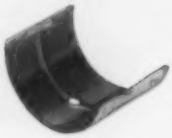
FEDERAL-MOGUL

DIVISION, Federal-Mogul-Bower Bearings, Inc.
11043 Shoemaker, Detroit 13, Michigan

BABBITT-LINED BEARINGS

BEARING-SURFACED THRUST WASHERS

SPACER TUBES



COPPER-LEAD BEARINGS

FEDERAL Mogul

SINCE 1899

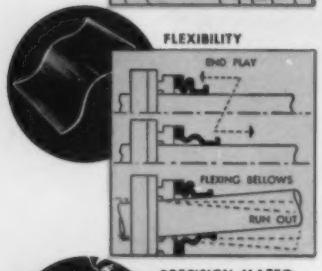
RESEARCH • DESIGN • METALLURGY • PRECISION MANUFACTURING

JOHN CRANE

Shaft Seal Design With A Purpose!

POSITIVE DRIVE

This gives long seal life. Drive is transmitted through the driving band and washer driving notch which absorb all breakout and running torque. Damaging stresses on the bellows or flexible sealing member are eliminated. Slippage is also eliminated, thus protecting shaft or sleeve against galling.



FLEXIBILITY

Axial and radial misalignment problems are eliminated. Self-adjusting bellows or sealing head automatically compensates for shaft end play or run out. Minimum spring pressure is required for axial shaft movement and uniform spring pressure is maintained during radial shaft movement.

PRECISION MANUFACTURE

Leakproof performance is assured. Washer and seat surfaces are precision lapped to a perfect mate under a patented "John Crane" process.

A SEAL FOR EVERY SERVICE

All "John Crane" Seals are constructed to the particular service requirements . . . from hot or cold water to the most destructive acids, corrosives and gases . . . temperatures up to 1000°F. . . . pressures to 1200 psi. They can be furnished in types and sizes to meet practically any mechanical or dimensional condition.

Request Bulletin S-204-2. Containing full information on "John Crane" engineered shaft seals.

GET COMPLETE DETAILS

Crane Packing Co., 6445 Oakton Street, Morton Grove, Ill. (Chicago Suburb)

In Canada: Crane Packing Co., Ltd., Hamilton, Ont.

JOHN CRANE

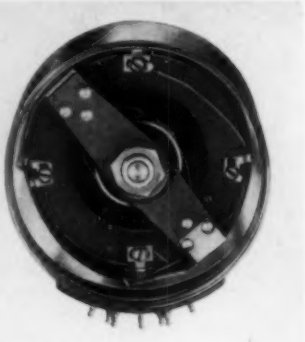
MECHANICAL PACKINGS | SHAFT SEALS | TEFLON PRODUCTS | LAPPING MACHINES | THREAD COMPOUNDS

CRANE PACKING COMPANY

in. Readings are accurate to 0.05 per cent absolute, with linearity greater than 0.01 per cent from a millivolt to 1,000 v d-c. A balance logic correctly positions the decimal point for the maximum number of significant figures under all conditions.

Weight is 25 lb. Size: 7x10x13 in. Power requirement is 115 v, 60 cps, 100 w average. Electro Instruments, Inc., 3794 Rosecrans, San Diego, Calif.

For more information— Circle 95, inside back cover



Sine-Cosine Function Potentiometer

Two separate voltage outputs may be obtained in this 3 in. enclosed unit. Independent brush contacts are mounted on a common shaft 90 deg apart to produce accurate sine and cosine voltages. Function accuracies of 1 per cent are standard; function angle is 360 deg.

Either sleeve or ball bearings can be supplied in a one-piece machined aluminum housing. Mounting designs include servo, three-hole with central pilot, or threaded bushing. Multiple ganged units are available with sections in simultaneous or other arrangements. DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y.

For more information— Circle 96, inside back cover

Subminiature Potentiometer

A ½ in. dia potentiometer has a one-piece, nickel-plated bronze case and bearing, sealed silicone glass fiber cover with end-mounted terminals, and an O-ring sealed shaft. Voltage

(Continued on page 310)

1. *By installing the line of Diesel Engines that is backed by world-wide sales, service and parts outlets.*

2. *Or by shipping your units—without motors—to almost any spot on earth, letting your customer install one of these diesels (at lower cost to him) at destination point!*

Perkins Diesels are in use in the following 118 countries and regions:

ADEN
AFGHANISTAN
ALGERIA
ANGOLA
ARABIA
ARGENTINA
AUSTRIA
AUSTRALIA
AZORES
BAHAMAS
BARBADOS
BELGIAN CONGO
BELGIUM
BERMUDA
BOLIVIA
BORNEO
BRAZIL
BRIT. CAMEROONS
BRIT. GUIANA
BRIT. HONDURAS
BRIT. N. BORNEO
BRIT. SOMALILAND
BURMA
CANADA
CEYLON
CHILE
CHINA
COLOMBIA
COSTA RICA
CUBA
CURACAO
CYPRUS
CZECHOSLOVAKIA
DENMARK
DOMINICA
ECUADOR
EIRE
EGYPT
FED. MALAY STATES
FINLAND
FIJI ISLES
FRANCE
FR. CAMEROONS
FR. EQUAT. AFRICA
FR. GUINEA
GERMANY
GIBRALTAR
GOLD COAST
GREECE
GUATEMALA
HAITI
HOLLAND
HUNGARY
ICELAND
INDIA
INDONESIA
ITALY
IRAQ
JAMAICA
JAPAN
KENYA
LIBERIA
LIBYA
LUXEMBOURG
MADAGASCAR
MADEIRA
MALAYA
MALTA
MAURITIUS
MEXICO
MOROCCO
MOZAMBIQUE
NEW GUINEA
NEW ZEALAND
NICARAGUA
NIGERIA
NORTH RHODESIA
NORWAY
NYASALAND
PAKISTAN
PALESTINE
PANAMA
PARAGUAY
PERSIA
PERU
PHILIPPINES
POLAND
PORT. GUINEA
PORTUGAL
PUERTO RICO
RUMANIA
SALVADOR
SAUDI ARABIA
SIERRA LEONE
SINGAPORE
S. RHODESIA
S. W. AFRICA
SPAIN
SUDAN
SWAZILAND
SWEDEN
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SYRIA
TANGANYIKA
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TRANS JORDAN
TRINIDAD
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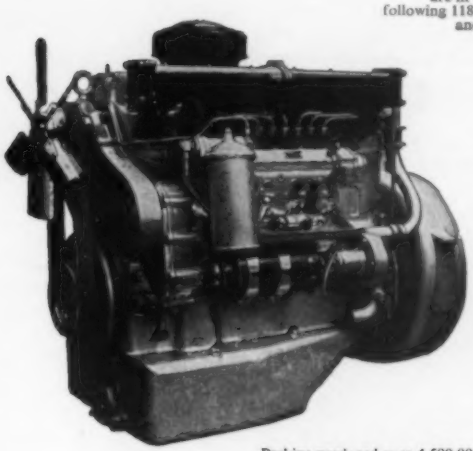
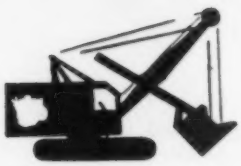
U.S.S.R.
VENEZUELA
WEST AFRICA
YUGOSLAVIA



Perkins produced over 4,500,000 brake horsepower in light, high-speed diesel engines in 1955. 70 % of this output went into the world markets—where Perkins Diesels set the world standard in motors up to 120 B.H.P.



The heavy export units you produce may be the finest of their kind. But unless you can guarantee adequate service and parts facilities on a world-wide scale for the diesel engines that power those units, world markets may be hesitant to buy them.

That is why F. Perkins Ltd. believe they can help you sell more export machinery. Perkins not only make a complete line of high speed, light weight diesel engines—they have sales, service and parts outlets in 106 countries as well! (See list on this page)

Also, these versatile engines are available to specifications of your own engineering department. Deliveries can be made from Sterling sources to you or direct to your overseas branches or distributors.

Perkins maintain an engineering staff in Toronto, Canada to work with your company. Simply phone them. They will fly down to discuss applications with you. Prototype installations can be made at Toronto or at your plant.

Make sure of expert diesel service and availability of engine parts for all your export units . . . cut shipping costs and assembly headaches . . . call Perkins Toronto Office today.

Perkins

F. PERKINS (CANADA) LTD.
wholly owned subsidiary of
F. Perkins Ltd., Peterborough, England

5611

UNIFLOW SWITCHES TO RUBATEX TUBING FOR SWEAT-PROOF INSULATION AT LESS COST

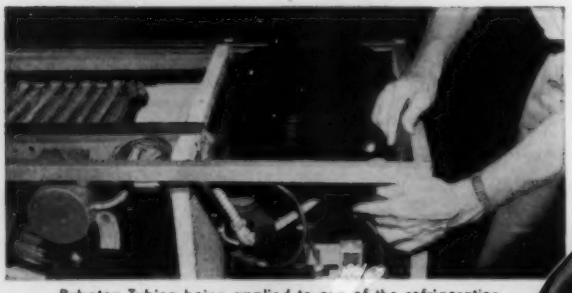
Cold lines in six Uniflow water cooler fountain models and ice cube maker now insulated with this new closed cellular rubber tubing insulation.

"We find Rubatex particularly applicable to our uses mainly because it doesn't absorb water and at the same time provides the insulation necessary at the points where it's used. We also believe Rubatex will last longer. *Lower initial cost and fast deliveries* were additional influencing factors in our switch to Rubatex."

L. E. Green, Chief Engineer
Uniflow Manufacturing Company
Erie, Pa.

Interior of a Uniflow fountain showing Rubatex as insulation on cold water line where it passes close to outside skin of fountain—thus preventing "sweating" of cabinet. Also refrigeration line where Rubatex Tubing prevents condensation and resultant "puddling" on floor.

See how easily Rubatex is slipped on the Uniflow cold water line. Rubatex is especially adaptable where carriers are curved. Will readily bend without cutting or fitting—fits snugly to any contour of pipes.



Rubatex Tubing being applied to one of the refrigeration tubes in Uniflow "Kold-Draft" ice cube maker. After inserting Rubatex over tube, an air hose is used to easily speed-up installation.

Rubatex's unique nitrogen-filled closed cellular rubber structure makes it resiliently soft and most adaptable as formed copper tubing insulation for any cold lines requiring sweating resistance . . . cannot absorb water . . . keeps pipes forever dry . . . eliminates any need for additional vapor barrier . . . gives it excellent weather-aging characteristics . . . plus unusually good fire-safe thermal insulation properties. What's more—initial cost of new Rubatex Tubing Insulation is surprisingly low and *deliveries can be made fast!*

Available in standard inside diameters of ¼" to 2" with ⅜" and ½" wall thickness. Other sizes can be made to specification. Produced in any lengths up to 250 feet. Can be slit for installed piping.

RUBATEX
CLOSED CELLULAR RUBBER
TUBING INSULATION

RUBATEX DIVISION, Dept. P-3
GREAT AMERICAN INDUSTRIES, INC.
Bedford, Virginia

For full details and sample of Rubatex Closed Cellular Rubber Tubing—print your name in space below, attach to your company letterhead and mail to us.

Name _____

Send for Free Sample and full details

Punch PRINTED CIRCUITS Cold...

with WALES Fabricator-Duplicator

The WALES **Fabricator** combined with WALES positive **Duplicator** is the modern, low cost answer to printed circuit hole punching. You get holes with sharp definition, clean walls and minimum bell mouth. This equipment is perfect for short runs from one piece to thousands. Change dies for hole sizes in seconds with a range up to 3½" dia. Accuracy is automatic and positive. Make your own templates, too, on the Fabricator. No need for drilling machines or jig-borers. The WALES Fabricator-Duplicator is a complete punching shop in itself.

See us at I.R.E. show New York
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Complete specifications and capacities are yours for the asking.

WALES Strippit COMPANY

"...the Wales-Way is the PLUS-PROFIT way"

AKRON, NEW YORK

WALES-STRIPPIT OF CANADA LTD., HAMILTON, ONT.

when you need
SPRING WASHERS

Pronto!

Call on Garrett
OF PHILADELPHIA

"D" & TIOGA STREETS • PHILA. 34, PA.
GARFIELD 6-4000

The thousands of dies in our stock permit the making of nearly every size Belleville, Bevel, Three-Wave, Four-Wave and many other types of Spring Washers to fit your Engineering requirements without extra tool charges and within just a few days after receipt of your order. Garrett's large stocks of spring steel, stainless steel, phosphor bronze and beryllium copper combined with our own plating, die-making, heat-treating facilities and rigid control permit fast shipment of standard or special washers—regardless of quantity.

Depend on GARRETT for all small parts.

FLAT WASHERS—Made to meet new ASA and SAE standards . . . available in steel, brass, bronze, monel, aluminum, and stainless steel . . . finished to your specifications.

HELICAL SPRING LOCK WASHERS—with controlled tension for tighter assemblies.

METAL STAMPINGS — Made to your specifications on high-speed production presses.

HOSE CLAMPS — Multi-Clamp, Auto-Seal and Spring-Grip Hose Clamps.

SEND FOR LITERATURE

GEO. K. GARRETT CO., D & TIOGA STS., PHILA. 34
Please send, without obligation, literature on the following:

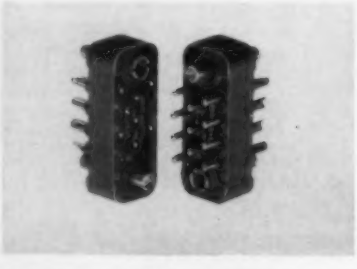
☐ FLAT WASHERS
☐ HELICAL SPRING LOCK WASHERS
☐ SPRING WASHERS
☐ HOSE CLAMPS
☐ STAMPINGS
☐ GARRETT STATISTICAL QUALITY CONTROL

Name_____
Title_____
Company_____
Address_____
City_____ State_____ PE-2

breakdown between shaft and terminals is a full 1000 v a-c.

Standard electrical rotation is 320 deg, mechanical rotation is 325 deg with stop or continuous 360 deg. Threaded bushing mounting designs are standard, servo or other mounting arrangements on order. Standard shafts are 0.125 in. dia stainless steel. DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y.

For more information—
Circle 97, inside back cover



Miniature Connectors

This connector has a 0.78 in. length, 0.27 in. width. Polarization is positive with a reversed guide pin and guide socket made of stainless steel. Floating contacts insure positive self-alignment of each contact. The precision machined phosphor bronze contacts are gold plated over silver for low contact resistance and soldering ease.

The connector is available in 7, 11, 14, 20, 26, 29 and 34 contacts, with or without aluminum hoods. DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y.

For more information—
Circle 98, inside back cover

Regulator for 400-Cps Generator

Two models of a transistor-equipped magnetic amplifier regulator will control virtually all exciter-

(Continued on page 314)

Why Parker O-rings seal better and last longer!

For trouble-free leakproof sealing, you can depend on precision-molded Parker O-rings. Laboratory and service tests check every detail of the manufacturing process. Precision-molding by exclusive methods assures accurately sized O-rings. And we have molds for over 296 standard O-ring sizes!

From Parker you get exactly the *right* O-ring for your *specific* application. We invite you to prove by comparison tests how Parker O-rings seal better and last longer. Our engineering service will be glad to help you with designing problems. Mail the coupon or ask your Parker O-ring distributor for catalog.

Parker
Hydraulic and fluid system components

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Section 521-U
The Parker Appliance Co.
17325 Euclid Ave., Cleveland 12, Ohio

☐ Please send O-ring Catalog No. 5701

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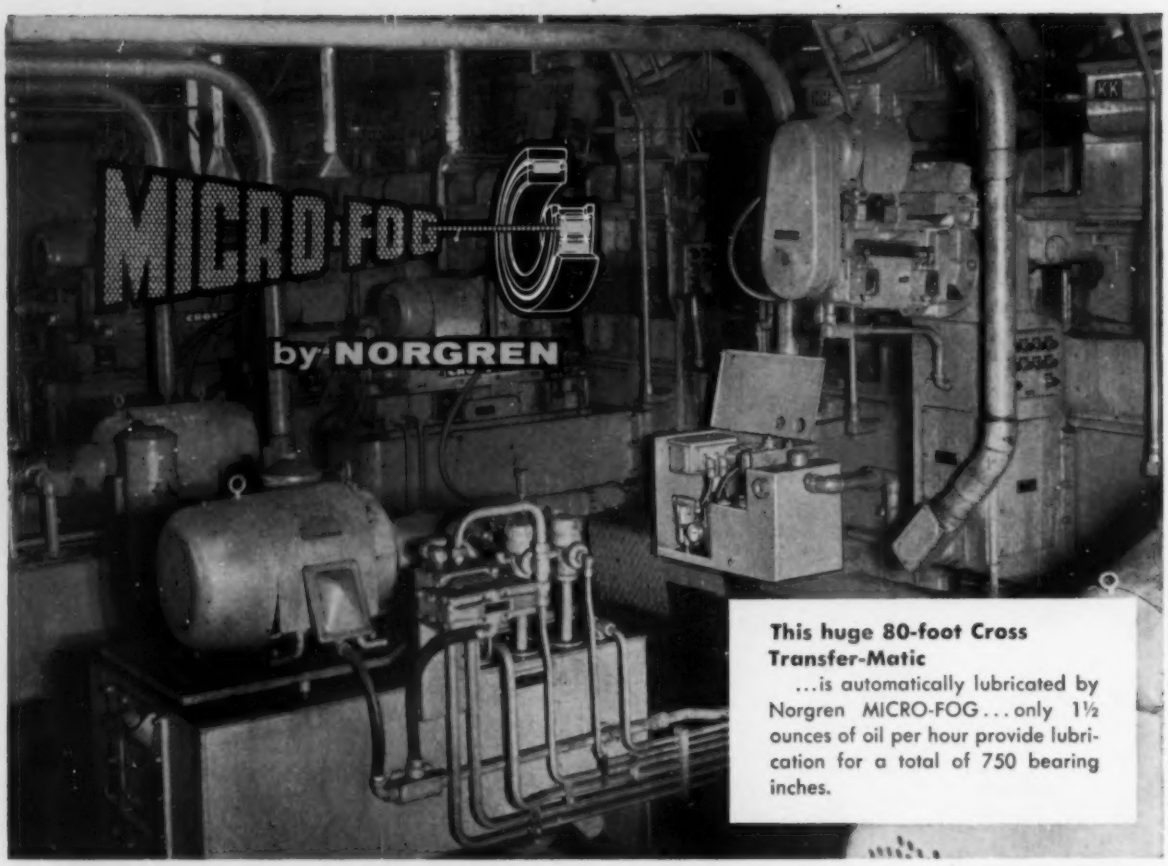


This huge 80-foot Cross Transfer-Matic

...is automatically lubricated by Norgren MICRO-FOG... only 1½ ounces of oil per hour provide lubrication for a total of 750 bearing inches.

AUTOMATIC *Air-Borne* LUBRICATION

for Bearings, Gears, Chains, Cams, Slides, Ways

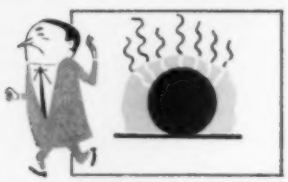
How Much Oil is REALLY Needed to Lubricate?

The only oil that lubricates is the thin film that separates the metal surfaces. Any additional lubricant is a waste and may even be harmful, causing over-heating due to fluid friction. With intermittent systems, there may be periods when there is not enough oil—and metal wears against metal.

Norgren MICRO-FOG Provides Optimum Lubrication

One MICRO-FOG Lubricator automatically coats all the bearings, gears, chains and other components of a machine with a continuous, protective film of fresh oil. Just the right amount of oil—no more, no less—is continuously applied to provide the most efficient lubrication, reducing wear on machine components and cutting maintenance and replacement costs.

For complete information, call your nearby Norgren Representative listed in your telephone directory—or WRITE FACTORY FOR NEW NO. 800 CATALOG.



TOO MUCH OIL—
Hot bearings due to fluid friction.

TOO LITTLE OIL—
Bearings run hot, wear excessively.

MICRO-FOG Lubrication—
Always just the right amount of fresh oil.

C. A. NORGREN CO.

3428 SOUTH ELATI STREET ..... ENGLEWOOD, COLORADO

Belt vibration is a design headache . . . eliminate it by specifying Veelos!

1 This test proves Veelos V-belts cut vibration up to 90%

Why chance running into vibration troubles when Veelos V-belts stop belt vibration before it starts. Particularly in designing for air conditioning, ventilating, refrigeration and precision equipment where belt vibration and noise are costly factors . . . *you owe it to yourself to see the Veelos Vibration Test* (above), before you specify. This test proves Veelos cuts vibration up to 90% over any belt you're using. The vibration story can become a big factor in selling your machines. With Veelos Belts you *assure* your customers of less bearing wear, less spoilage and less downtime.

2 Specify Veelos for a smoother-running drive

Ordinary V-belts have varying spots of density, due to their construction, which throw them out of balance. Veelos Belts are absolutely uniform; every stud and link identical; every foot of the reel is perfectly balanced. The beveled links, the machine-cut sides add up to better vibrationless performance. And by specifying Veelos, you're doing yourself a big favor . . . because your customers will be more pleased with the added efficiency of your machines. Your Veelos salesman can give you proof that Veelos outperforms any other V-belt, by test, right before your eyes.

3 Veelos allows you complete design freedom, too!

With Veelos you fit the belt to the drive, not the drive to the belt—because Veelos is adjustable to any length. You can use outboard bearings to advantage because Veelos is installed easily without dismantling any part of the machine. With Veelos you need not design for belt adjustment—no idler, no slide rail or any other belt-tightening device is needed. Simply add or delete links; that's all; no tilting or moving motors. A 15 minute demonstration shows you the many advantages Veelos offers.

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VEELOS
THE BALANCED
LINK V-BELT

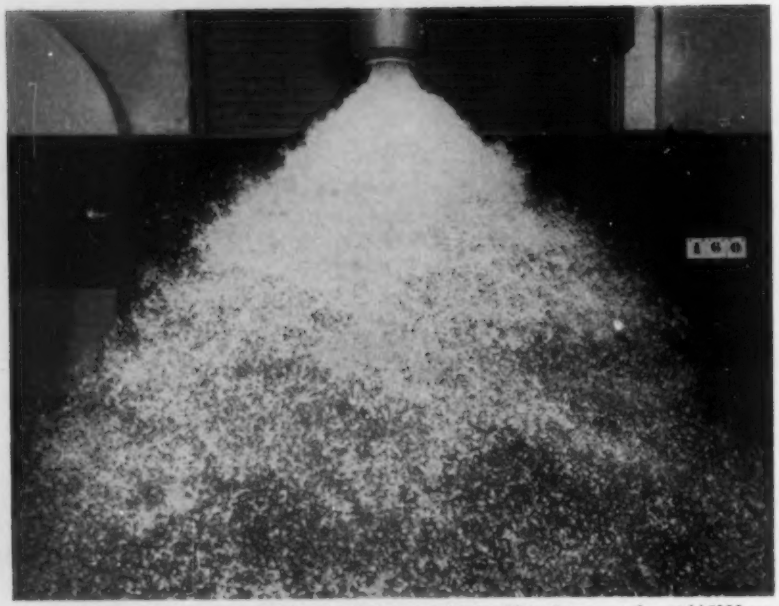
Veelos is known as Veelink outside U.S.A.

For free vibration demonstration and Veelos Data Book write to:

MANHEIM

Manufacturing & Belting Company
207 Stiegel St., Manheim, Pa.

"Industrial Belt Specialists Since 1911"



Spraco full-cone, free-flow nozzle discharging 860 gpm at 5 psi. This photo was taken at 1/5000 sec. shutter speed . . . at this speed the pulsations of the pump are apparent in the spray pattern.

RADICALLY NEW!

full-cone FREE-FLOW *nozzles from* SPRACO

Spraco's totally new, full-cone free-flow nozzles have been specially developed for high capacity, low pressure installations where clogging is a problem and full-cone spray pattern a necessity. Streamlined internal vane construction, with maximum vane openings, offers minimal flow resistance, virtually eliminates clogging.

STANDARD MATERIALS — bronze, cast iron, or stainless steel. Or, to order from any cast, machineable material.

SPRAY CHARACTERISTICS — uniformly distributed full cone spray.

PIPE CONNECTION — 4″–8″.

CONNECTIONS — screwed or flanged.

APPLICATIONS — cooling towers, chemical processing, coke quenching, aerating and purifying water supplies, cooling ponds, packed towers, absorption towers, etc.

Spraco welcomes your spray nozzle problems. As a leading consultant to industry for over 42 years, we are at the forefront in special nozzle development.

Write today for free, 30-page nozzle catalog. A complete selection of standard nozzles are available from stock.

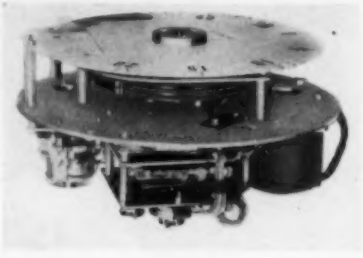
SPRAY ENGINEERING COMPANY

133 Central Street, Somerville 45, Mass.

excited 400-cycle generators at 120, 208, or 440 v, over a range of 380 to 420 cps. As available from stock, the unit is usually supplied with three-phase sensing, but is also offered with single-phase sensing.

The regulator is said to keep alternator output voltage within ± ½ per cent for all steady-state load conditions over the entire frequency band. Its inherent response time of 1/400 sec means the exciter field voltage will become maximum or minimum as required. Electric Regulator Corp., Norwalk, Conn.

For more information—
Circle 99, inside back cover



Self-Balancing Servo-Mechanism

The mechanism consists of a group of standard instrument parts assembled on a circular base, and fitted with an indicating scale. When used with an amplifier, input transformer, and d-c to a-c inverter, it forms a complete self-balancing dial indicator.

The unit is available as a potentiometer or as an a-c bridge. Dial indicator speeds of 1, 3 and 4½ sec are offered, and one blind set alarm switch can be furnished. The unit can also be supplied with a re-transmitting slidewire. Bristol Co., Waterbury 20, Conn.

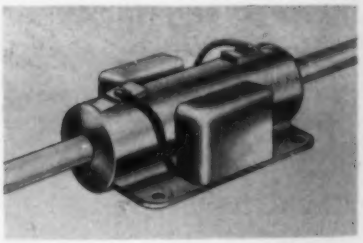
For more information—
Circle 100, inside back cover

FLUID POWER, CONTROL

Ultrasonic Flow Measurement

Because this instrument offers no obstructions to the fluid flow, pressure drop is said to be eliminated, maintenance simplified and accuracy

(Continued on page 315)



consistently attained. It is especially adapted to measurement of such difficult liquids as kerosene, liquid oxygen, water and similar low viscosity fluids. This unit will measure flow rates in the range of 1000 to 4000 gpm, with an accuracy of better than 1 per cent, and provides 5 v full scale output to feed into standard telemetering and recording systems. Gulton Industries, Inc., 212 Durham Ave., Metuchen, N. J.

For more information—
Circle 101, inside back cover

Stainless Steel Actuator

Designed to operate within a temperature range of −67 F to 600 F, this actuator is hydraulically operated over a range of pressures of 0 to 3000 psi. It can also be adapted to pneumatic operation.

The actuator pictured here has a stroke of 7 in. They are 16 x 2⅜ in. dia. Ex-Cell-O Corp., 1200 Oakman Blvd., Detroit 32, Mich.

For more information—
Circle 102, inside back cover

Manifold for Two, Three, Four-Way Valves

Available in two and three-station types, the cast aluminum manifold has full-length inlet and exhaust ports, both 1 in. NPT, common to all valve stations. Electrical wiring is run through a 1¼ in. NPT conduit passage, with one access cover for all stations to simplify wiring. Pilot solenoid leads are enclosed in dirt and moisture-proof flexible conduit. The manifolds

(Continued on page 317)

Special Ⓑ Fasteners—Sample brochure sent upon request

NO JOB TOO TOUGH FOR Ⓑ SPECIALS

These Ⓑ Specials were made to rigid specification... to withstand severe operating conditions... to assure outstanding service where regular fasteners proved inadequate.

If your fastening problem concerns these important factors, it will pay you to talk it over with Ⓑ engineers.

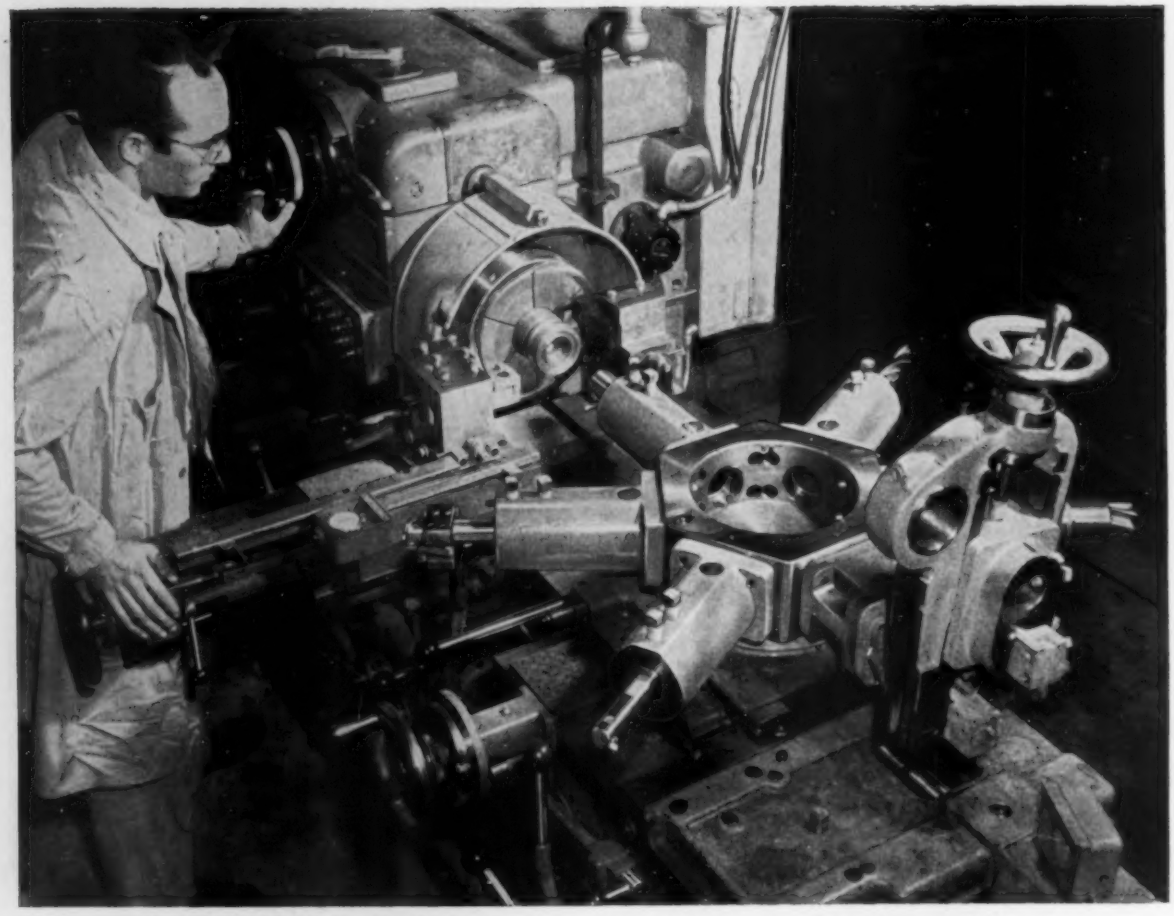
The knowledge and experience gained by Buffalo Bolt in more than 100 years of difficult assignments will assure you the most competent advice in the industry... the most economical service in the fastening field.

BUFFALO BOLT COMPANY
Division of Buffalo-Eclipse Corporation
NORTH TONAWANDA, N. Y.

• *3 convenient service centers*

WESTERN OFFICE	EASTERN OFFICE	CENTRAL OFFICE
Chicago	New York City	North Tonawanda
HArrison 7-2179	REctor 2-1888	JAckson 2400 (Buffalo)

Many **GOOD** *products can be made* **BETTER** *...with* Ⓑ **SPECIAL FASTENERS**



New Gisholt 30 H.P. Turret Lathe features a compact, integrated headstock, bedframe design. Nickel alloyed components help keep the 12-speed unit running smoothly . . . dependably at top performance. Produced by Gisholt Machine Co., Madison, Wisconsin.

Gisholt depends on nickel alloy steels for highly stressed parts in new saddle-type turret lathes

In Chuck Screws—carburized type 3312 nickel chromium steels with wear resistance plus a tough case to prevent thread chipping, and a strong core to carry heavy torsional loads.

In Certain Headstock Gears—type 4620 Ni-Mo case-hardened to provide wear resistance and strength with a minimum of distortion during heat-treatment.

In Drive Pinions for Hexagon Turret Saddles—where 4340 Ni-Cr-Mo steel quenched and tempered to 40-45 Rc has proved its uniformity and reliability through years of service.

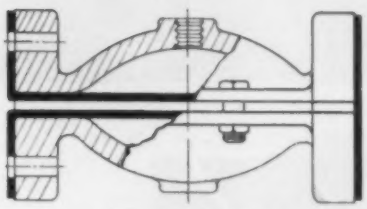
Three problem parts! Three practical solutions for Gisholt! All proved . . . with nickel alloy steels. What about critical metal parts in *your* products?

Chances are, too, that solutions to the problems they present lie in the outstanding combinations of properties available from steels containing nickel. Why not take advantage of Inco's available knowledge of the capabilities of nickel steels. Send us the details of your problem, and we will be glad to suggest possible solutions.

INCO TRADE MARK **THE INTERNATIONAL NICKEL COMPANY, INC.** 67 Wall Street New York 5, N.Y.

are designed with side or bottom cylinder porting to facilitate piping. Holes for mounting the manifold and valve assembly are also provided. The manifold is offered with $\frac{3}{8}$ or $\frac{1}{2}$ in. cylinder ports. Kits of O-rings and through-bolts, for ganging manifolds end-to-end, are also available. Valvair Corp., 454 Morgan Ave., Akron 11, Ohio.

For more information—
Circle 103, inside back cover



Control Valve for Low-Flow

This small diameter valve series was designed for remote control. Sleeve sizes from $\frac{1}{16}$ to $\frac{1}{4}$ in. are interchangeable using the same valve body. Specifying five tubes will provide wide-range flow control for laboratory, pilot plant or process applications.

Remote control operating medium may be either pneumatic or hydraulic. Red Jacket Co., Inc., 500 Bell Ave., Carnegie, Pa.

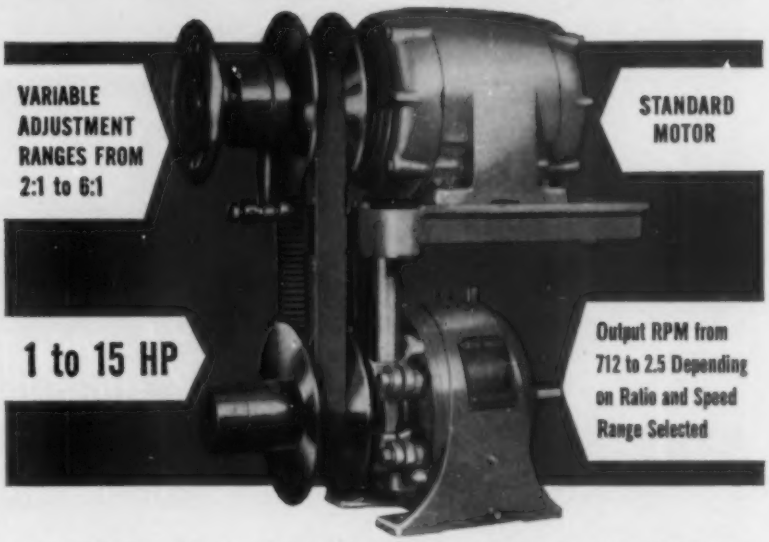
For more information—
Circle 104, inside back cover

Needle Valve

These needle valves are manufactured from PVC, Teflon, Kel-F, and Type 18-8 stainless steel. They are available in $\frac{1}{8}$ and $\frac{1}{4}$ in. female pipe sizes and $\frac{1}{8}$, $\frac{1}{4}$ and $\frac{3}{8}$ in. OD male tube connections. They operate in temperatures to 170 F, and up to 170 psi

(Continued on page 320)

NEW FROM FOOTE BROS.
Vari-Mount
VARIABLE SPEED MOTORIZED DRIVE


VARIABLE ADJUSTMENT RANGES FROM 2:1 to 6:1
STANDARD MOTOR
1 to 15 HP
Output RPM from 712 to 2.5 Depending on Ratio and Speed Range Selected

VARI-MOUNT—the new Variable Speed Motorized Drive offers infinitely variable speed selection, greater flexibility of operation, wide adaptability, easier maintenance and the sound design you expect from Foote Bros.

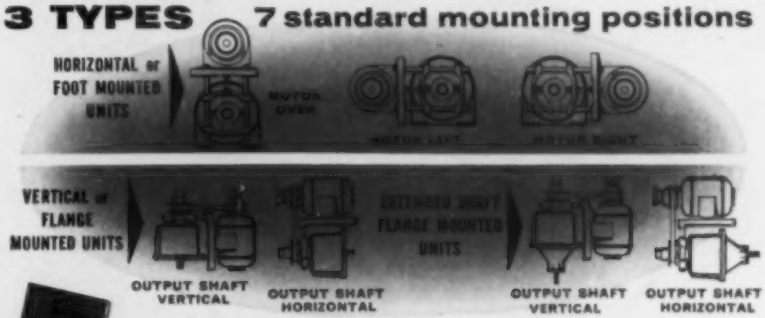
With a Vari-Mount, you can use your own motor—old or new NEMA Standard—or, the unit can be supplied with any standard motor of your choice. The Vari-Mount Reducer incorporates Duti-Rated Lifetime Gearing with file-hard tooth surfaces and tough, ductile cores for maximum life and efficiency.

Positive handwheel control of the adjustable pulley permits pin-point accuracy in speed selection over the entire range. Vari-Mount Units may be equipped with Remote or Automatic speed selection devices if required.

Spring loaded, self-centering Variable Pulley and close-coupled in line design insures permanent belt alignment, smoother performance, and minimum overhung load on motor bearing. No thrust load is imposed on motor bearings at any speed or during speed changes.

Quick belt changes made possible by the wide-open design of the Vari-Mount, together with easily accessible lubrication fittings make maintenance an easy matter.

3 TYPES 7 standard mounting positions



Want complete details?...Write for Vari-Mount Catalog today

this trademark stands for the finest industrial gearing made

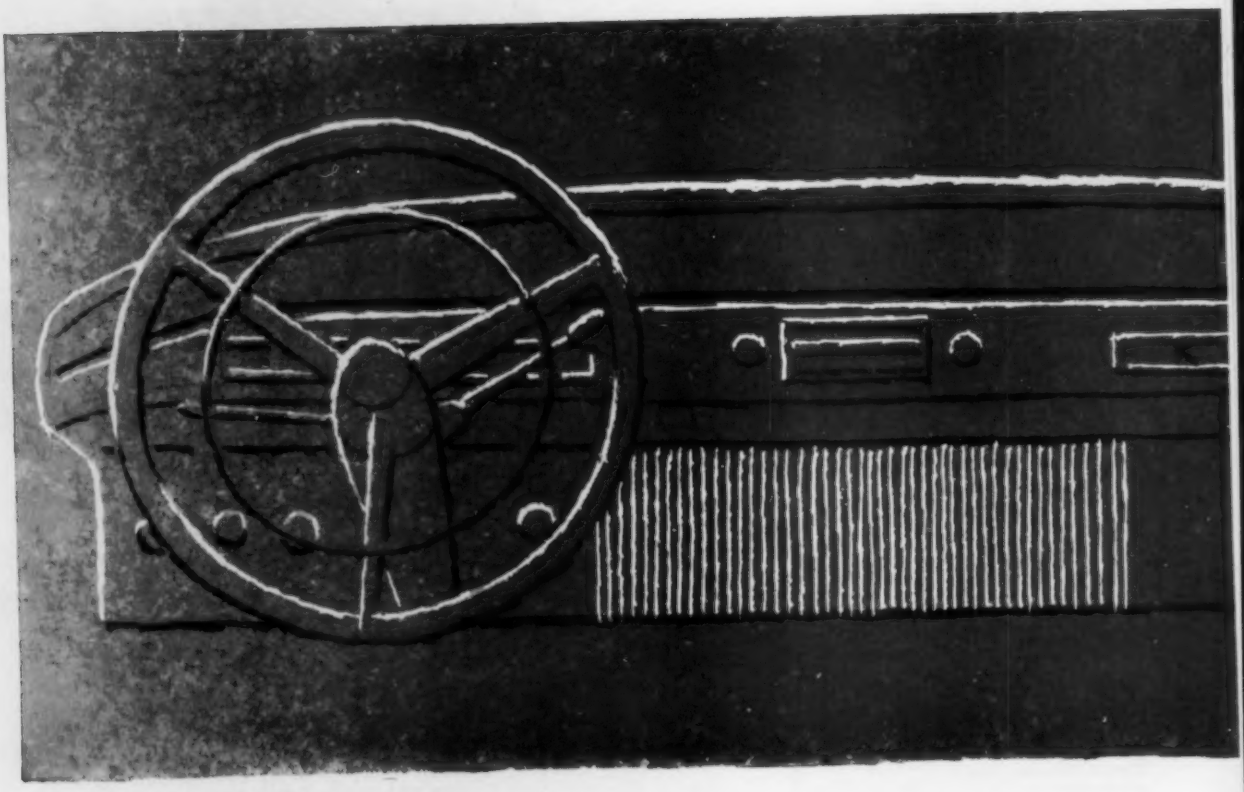
T. M. REG. U. S. PAT. OFF.

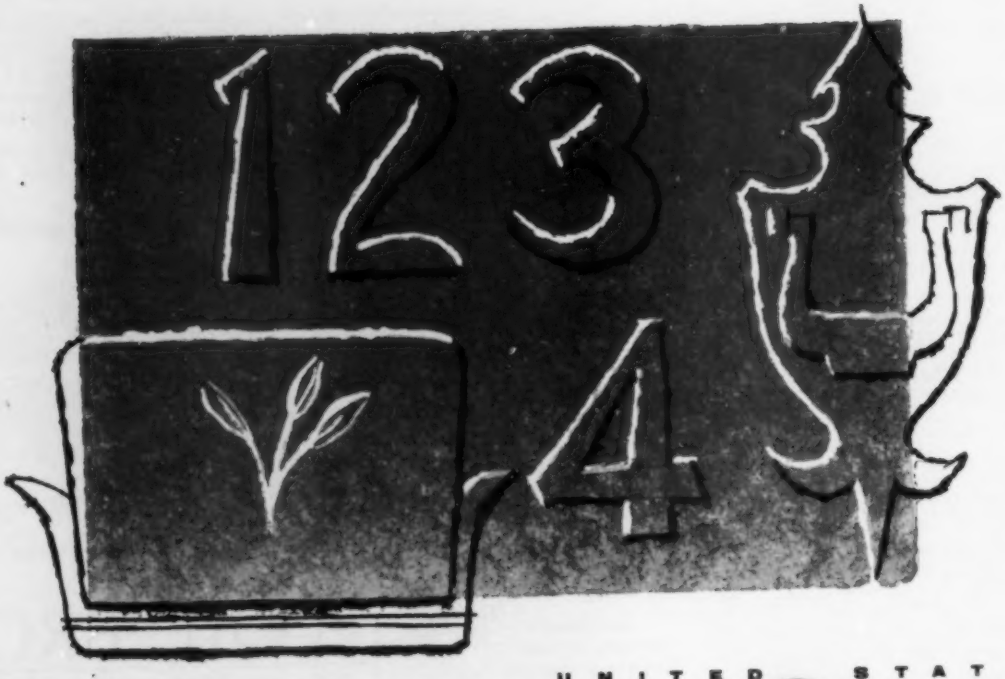
FOOTE BROS. Duti-Rated LIFETIME BEARING

FOOTE BROS.
Better Power Transmission Through Better Gears

FOOTE BROS. GEAR AND MACHINE CORPORATION
4575 SOUTH WESTERN BOULEVARD · CHICAGO 9, ILLINOIS

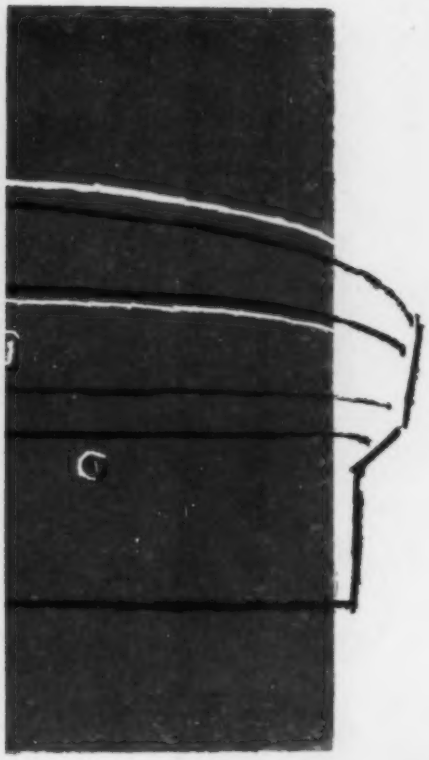
DECORATION





UNITED STATES
USS

that can't fall off, rub off, or chip off!

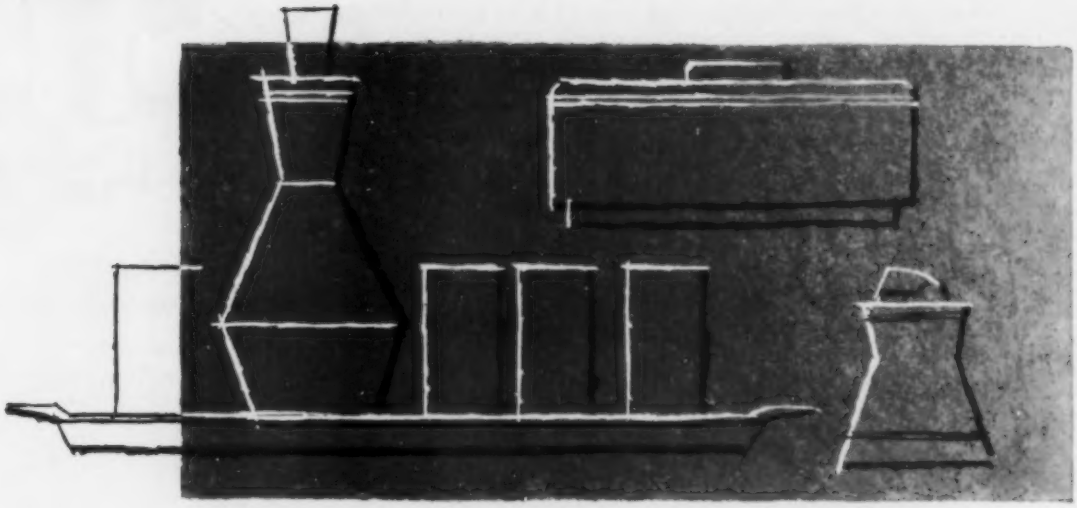


EMBOSSED STRIP STEEL

Embossed strip steel—with the pattern built right in the steel—is an exciting and salable way to decorate products of steel. It is a way to add durable texture to an automobile dashboard, distinctive pattern and design to an automatic toaster. It is a way to add permanent charm and character to hinges, escutcheons, or other hardware items.

It is the low-cost way to dress up a product, because you don't have to apply the pattern. It is right in the raw material, put in at the steel mill. And put in to stay.

Tailored to your product! Amerstrip steel—either embossed or plain—is always tailored to a specific use. You get the exact shape, finish, ductility and other characteristics that you need. As a result—you can often build a better product, more economically, by making it from Amerstrip.



Call any sales office of American Steel & Wire for more information about the availability and uses of Amerstrip in carbon, alloy, or stainless grades.

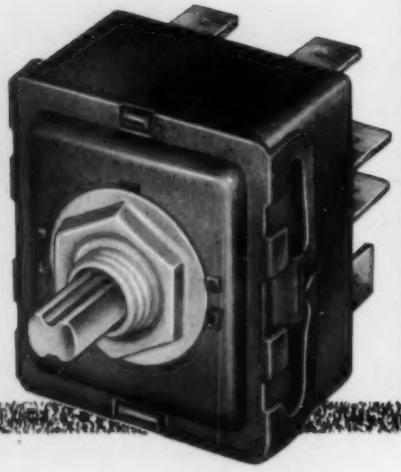
STEEL

AMERICAN STEEL & WIRE DIVISION • UNITED STATES STEEL CORPORATION
GENERAL OFFICES: CLEVELAND, OHIO • COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA., SOUTHERN DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

AMERSTRIP

Need a Small Switch For a Big Job?

'DIAMOND H' SERIES 390 SWITCHES



For air conditioners, fans, unit heaters, appliances and similar products . . . in motor or resistive circuits . . . Series 390 Rotary Switches have capacities out of all relation to their size.

Though UL approved ratings range up to 25 A. at 120 or 240 V., and ½, ¾ and 1 h. p. at 120 V. and 2 h. p. at 240 V., A. C., with small D. C. ratings also available, *the base of this switch measures only 1½" x 1¼" x ⅞"!* And they are available for from two to 12 positions, with or without stop as required.

HELPS SIMPLIFY YOUR DESIGN

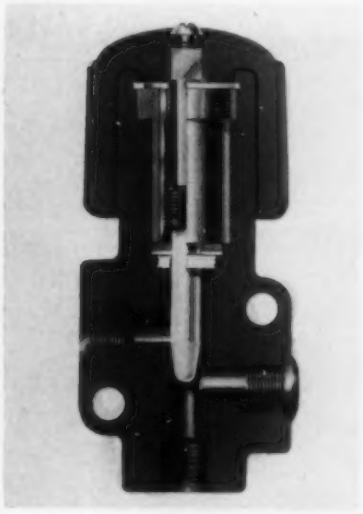
Spindles of Series 390 switches may extend through the base to permit ganging of mechanical and electrical controls. Dummy terminals may be provided to eliminate need for separate blocks. Spade terminals make for fast connections.

Completely interchangeable with the widely used "Diamond H" Series 240 Switches, which are still available, Series 390 includes both single and double pole models for single, two-hole or special mounting arrangements.

Tell us your requirements.

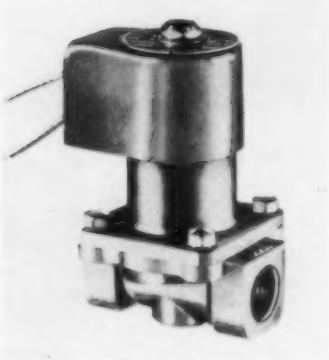
THE HART MANUFACTURING COMPANY

206 Bartholomew Avenue, Hartford, Conn.



or higher for intermittent duty. Chemtrol Corp., 1513 W. El Segundo Blvd., Compton, Calif.

For more information—
Circle 105, inside back cover



Solenoid Valve for Steam Control

The two-way valve may be used for automatic control of steam, hot fluids or gases (up to 400 F). The internal pilot-operated valve has a forged brass body and bonnet. Teflon discs are provided. There are no stuffing boxes or sliding glands. Automatic Switch Co., 391 Lakeside Ave., Orange, N. J.

For more information—
Circle 106, inside back cover

Pressure Gage Protector

Designed to protect gages from pressure surges, this diaphragm-type unit will automatically cut out the gage and by-pass the working media when

(Continued on page 322)

FASTEX

your source for savings in

component design and production

Here, Perspective Engineering conceives and creates fasteners and components of metals and plastics for mass-assembly. Skilled craftsmen produce these parts by the millions in integrated manufacturing facilities. Through this unique combination of talent and machinery, industry is served with maximum design flexibility and production speed. Assembly time is saved, costs are reduced.

FASTEX® PARTS PICTURED ABOVE ARE: 1. **Q Fasteners (T.M.),** fasten with a quarter turn. 2. **Plasti-Supports (T.M.),** blind-assembly shelf supports. 3. **Plasti-Grommets®,** self-retaining blind screw receptacles. 4. **Plasti-Plugs®** improve product appearance. 5. **Molding Clips** are self-adjusting, vibration proof. 6. **Plasti-Rivets®,** one-piece, self-expanding for blind assembly. 7. **Springrip Fasteners** with internal teeth. 8. **Plasti-Rings®,** self-retaining plastic shaft retainers. 9. **Precision Stamped Gears,** complete range of types and sizes. 10. **Speed Nuts®,** economical self-retaining nuts. 11. **Engineered Stampings** speed assembly. 12. **Plastinite®** one-piece strain-relief grommets. 13. **Nylon Spiroid®** Gears offer new space and weight economies. 14. **Engineered Molded Plastic Parts,** low-cost, time-saving.

FASTEX

DIVISION OF ILLINOIS TOOL WORKS
195 Algonquin Road, Des Plaines, Illinois

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Toronto, Ontario

itw

do YOU use time delay relays?

Do you require ADJUSTABILITY? ... No Problem!
Do you require HERMETIC SEALING? ... No Problem!
Do you require BOTH? NO PROBLEM for the

A. W. HAYDON Company

The A. W. Haydon Co. offers a complete line of ADJUSTABLE — HERMETICALLY SEALED TIME DELAY RELAYS for operation under adverse environmental conditions

Write for Bulletin AWH TD401

Bulletin AWH TD401 Describes
6400 Series — DC units
11400 Series — AC units
24300 Series — 400 cycle units
Nominal Range of Adjustment: 8-1
Timers supplied with:
AN connector
Hermetic Adjusting Knob
Glass Window and Calibrated Dial

Illustrated above are a few of the many environmental conditions which these compact timers are designed to withstand. More rigid requirements frequently can be met upon special consideration.

VISIT US AT THE I.R.E. SHOW, BOOTHS 2701 & 2703.

The A. W. HAYDON COMPANY
221 NORTH ELM STREET
WATERBURY 20, CONNECTICUT
Design and Manufacture of Electro-Mechanical Timing Devices

NEW STACOR-MATIC

the drafting table that makes engineering sense

- Increase productivity, efficiency
- Save man-hour costs • Reduce waste motion
- A complete work-station in one unit

Get all the facts—send for illustrated Bulletin 603 and complete Stacor catalog

STACOR EQUIPMENT CO.
788 East New York Ave., Brooklyn 3, N. Y.

line pressures rise above the spring setting in the protector. Suitable for air or poisonous gas service, the protector has an external pressure-adjusting control which permits accurate pressure settings from 10 to 100 psi. The units are available with ¼ in. connections and have brass bodies. Superior Hydraulics Div., 15201 St. Clair Ave., Cleveland 10, Ohio.

For more information—
Circle 107, inside back cover

Solenoid Valve for 6000 Psi

Weighing 0.7 lb with a flow area of approximately 0.125 in., this valve's solenoid is activated by 28 v d-c, or can be made available for an operating current of 124 v, 400 cps, a-c.

The valve can be furnished either normally open or normally closed. Valve body is forged with stainless steel interior. Marotta Valve Corp., P. O. Box 330-40, Boonton, N. J.

For more information—
Circle 108, inside back cover

Oil-Free Dry Air Pump

This air pump weighs 5 lb. 10 oz. It is rated at 40 cfm zero pressure delivery or 30 cfm (free air), 10 psi delivery at 7500 rpm. It is equipped

(Continued on page 326)

Often seen in Engineers notebooks

GEAR SOURCES

1. Illinois Gear

A dependable outfit that can fill any gear order. They talk "quality" and that's exactly what they give us. They deliver on time! Emergency service when needed.

They always meet our specs.

Ed—
Will use Illinois Gear as our source. I like their quality and service too!
J. R.

Look for this mark (ILL) the symbol on finer gears

ILLINOIS GEARS

Gears for Every Purpose ... one gear or 10,000 or more

ILLINOIS GEAR & MACHINE COMPANY

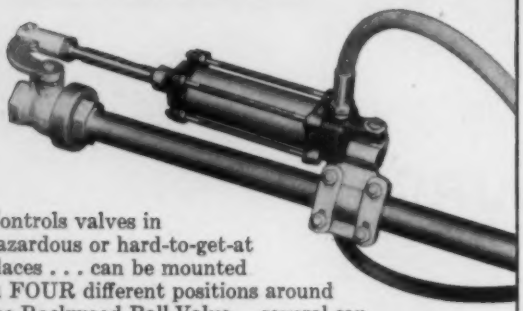
2108 NORTH NATCHEZ AVENUE • CHICAGO 35, ILLINOIS

Rockwood Ball Valves

- *Full round pipe size flow*
- *Leakproof service*
- *¼ turn opening and closing*
- *No maintenance*

Air-Operated Ball Valves

For remote control use

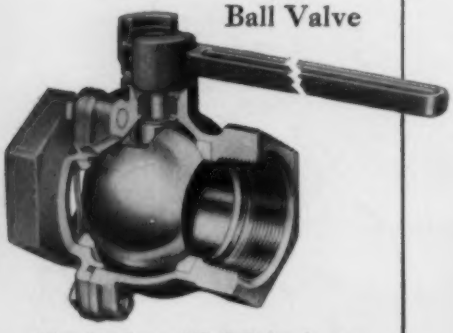


Controls valves in hazardous or hard-to-get-at places . . . can be mounted in FOUR different positions around the Rockwood Ball Valve...several can be controlled from one control board...available in a complete package unit from your distributor.

Male Thread Bronze Ball Valve

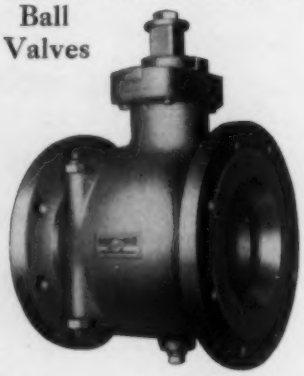
Full flow . . . with thread end, flanged end, union end or combination of same available with this valve. Longer life . . . greater strength. Size 2½" only.

Steam Ball Valve

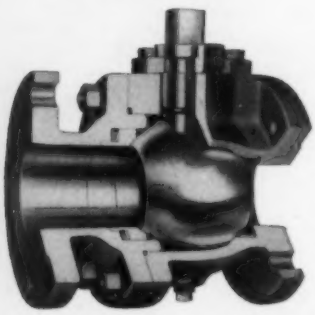


New Rockwood Ball Valve for use with steam handles up to 125 pounds of steam per square inch and 350 degrees F, with ease . . . opens and closes quickly. Pipe sizes ⅜" to 2".

6" and 8" Cast Steel Ball Valves



3" and 4" Cast Steel Ball Valves



Combines best features of plug cocks, gate and globe valves . . . made of medium carbon cast steel that meets specifications for carbon steel pressure castings as embodied in ASTM. Also made in other materials.

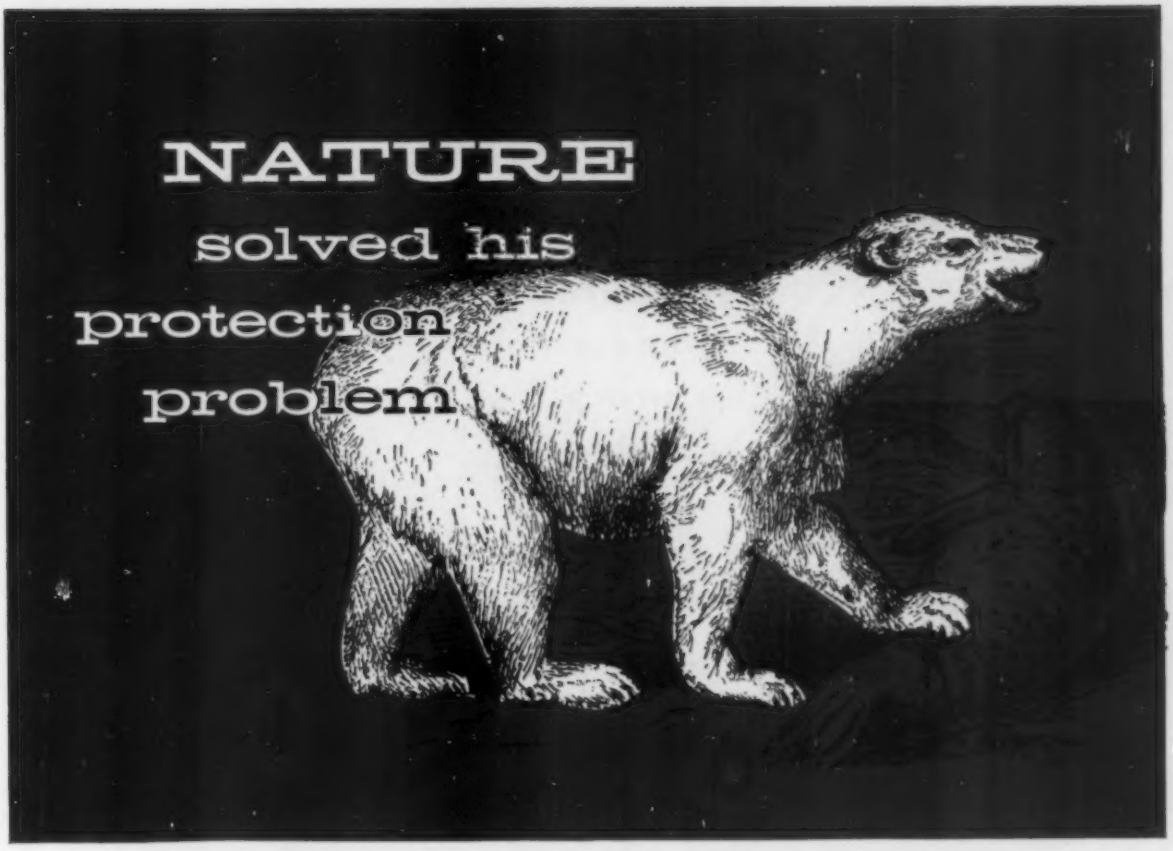
ROCKWOOD BALL VALVES

FULL, ROUND FLOW

Write for complete data to Rockwood Sprinkler Company, 1310 Harlow St., Worcester 5, Mass. Distributors in all principal industrial areas.

ROCKWOOD

Tested and listed by Underwriters' Laboratories, Inc.



we have 50,000* solutions to yours

Unlike the coats of the Arctic Hare and the Arctic Fox, which darken with Summer, the Polar Bear's coat remains white the year 'round. Nature has given him *continuous protection* against the Arctic background!

*durapol®, a new addition to the Maas & Waldstein Co. family of more than 50,000 *exclusive* formulas, is a synthetic baking enamel that also provides a unique kind of lasting protection. One coat, for example, not only provides a *whiter* white than ordinary white enamels, but a white that is ultra resistant to *yellowing!* As for hiding qualities, **DURAPOL** provides unequalled opacity...and thus, unequalled mileage too! **DURAPOL** is available in unlimited other colors, all offering these and the many more advanced **DURAPOL** characteristics. Typical **DURAPOL** applications include home appliances, lighting fixture reflectors, and all other products requiring good ultra-violet resistance as well as salt spray and stain resistance.

Write for more information on DURAPOL today!

M&W Co. 1876

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Helicoid Gages

an ACCO product

Acaloy Flanged Case

Helicoid gages set new standards of enduring accuracy, trouble-free service, and economy

Acaloy Flangeless Case

Phenol Turret Case

Acaloy Flush Case

Acaloy Square Flush Case

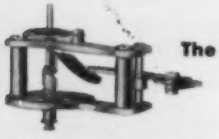
Industry has found in the HELICOID Gage, the most durable and efficient instrument ever devised to meet pressure-indicating requirements.

No Gears—No Teeth to Wear Out!
The exclusive HELICOID Movement is a simple, gearless cam-and-roller design with no teeth to wear out. It provides long and trouble-free service with a minimum of maintenance.

Sustained Accuracy—Longer Life
Because of advanced design, quality control in manufacture, and endless testing, HELICOID Gages produce more sensitive response to pressure changes. Their accuracy *endures*—even after millions of cycles.

Lowest Cost per Gage per year
These gearless gages go on performing day in and day out with little or no maintenance. This economy, together with long life, adds up to the fact that HELICOID Gages cost less per gage per year than any other gage you can buy.

Gages for vacuum and compound service. Pressure ranges up to 20,000 psi.

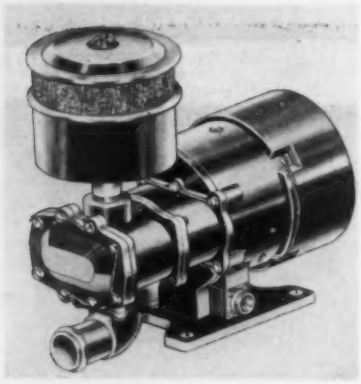


The Helicoid Movement

ACCO

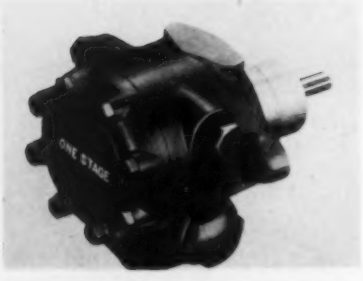
Helicoid Gage Division
AMERICAN CHAIN & CABLE
929-D Connecticut Avenue • Bridgeport 2, Connecticut

for Better Value



with an air cleaner and a 400 cps a-c electric motor. Motor is continuous duty, totally enclosed type, rated at 2.8 hp at 7500 rpm. Pesco Products Div., Borg-Warner Corp., 24700 N. Miles Road, Bedford, Ohio.

For more information—
Circle 109, inside back cover



Pump for Lubricants and Hydraulic Fluids

Designed to handle lubricating, hydraulic and light fuel oils at pressures up to 300 psi and speeds to 1800 rpm these pumps have a capacity of 24, 30 or 39 gph with either right or left rotation versions available. The pumping action produces a vacuum of 20 to 25 in. of mercury max. Sundstrand Machine Tool Co., 2210 Harrison Ave., Rockford, Ill.

For more information—
Circle 110, inside back cover

ENGINEERING MATERIALS

Silicone Rubber Packing

This silicone sponge rubber is a relatively soft material with the same qualities as regular silicone rubbers.

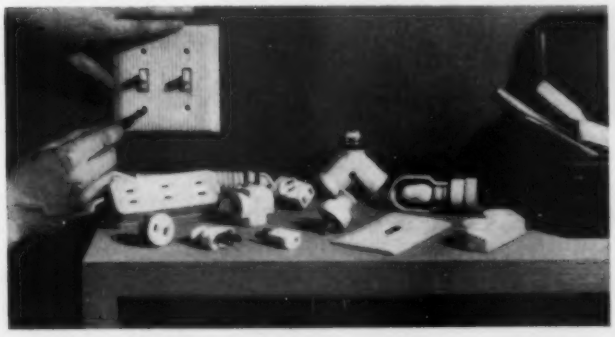
(Continued on page 330)

CYANAMID

PLASTICS NEWSFRONT

CYMEL* IN ELECTROSURGERY

High-frequency current flows between two sharp electrode tips in the 789 Bi-Active Coagulation Set used by physicians for removal of cervical cysts, tonsils and surface growths. The Birtcher Corp. of Los Angeles encases the electrodes in mineral-filled CYMEL Melamine Molding Compound because of its excellent insulating properties and smooth flow into the mold which simplifies accurate spacing of the tips. Handles and cord tips are molded of alpha-cellulose-filled CYMEL, also an excellent insulator. All surfaces are exceptionally hard, chip resistant and can be sterilized easily. *Trademark



MODERN TOUCH IN WIRING DEVICES

Home styling today favors light, cheerful colors. This note is carried out perfectly with wiring devices molded of ivory-colored BEETLE® Urea Molding Compound. Its hard, smooth surface resists discoloration and scratching, and safe dependable service is insured by BEETLE's excellent insulating properties.

WOOD CHIPS BUILD A WALL

These attractive panels are made of wood particles bonded with MELURAC® Melamine-urea Resin. This low-cost particle board has good warp resistance, flexural strength, moisture resistance and easy working and finishing properties. In addition to structural uses—walls, sliding doors, partitions, ceilings, subflooring, parquet flooring—it is ideal for furniture core and underlayment of decorative melamine laminates. MELURAC 304, developed expressly for this use, imparts no color and improves strength of the particle board.

AMERICAN CYANAMID COMPANY
PLASTICS AND RESINS DIVISION
30 Rockefeller Plaza, New York 20, N. Y.

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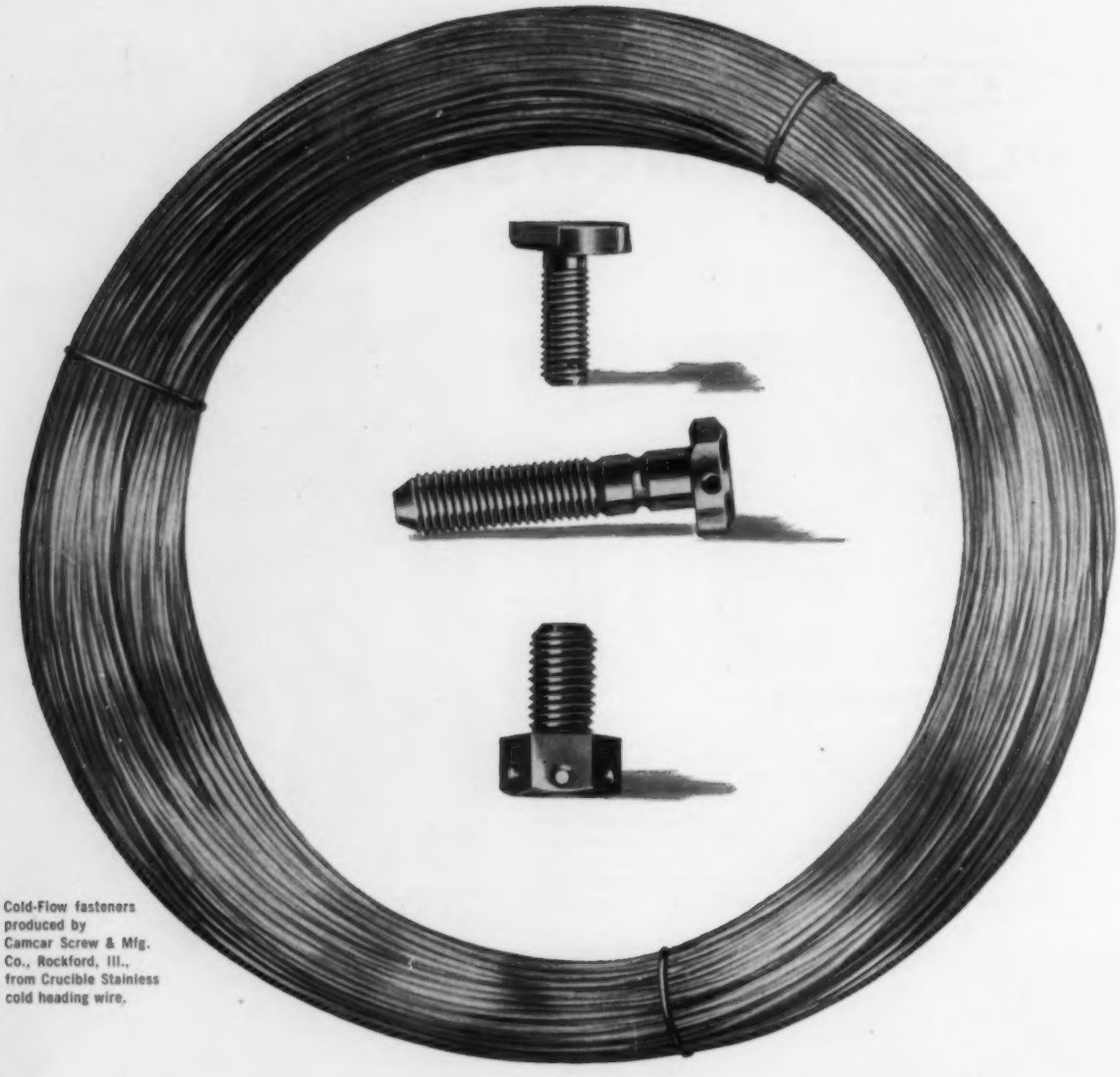
CYANAMID Plastics and Resins Division
MATERIALS FOR TOMORROW



Cold-Flow fasteners produced by Camcar Screw & Mfg. Co., Rockford, Ill., from Crucible Stainless cold heading wire.

fast delivery–wide selection on CRUCIBLE STAINLESS STEEL WIRE

Shipments are prompt on all standard types of Crucible stainless wire—including cold heading, spring, welding, and fine wires. And you have your choice of the widest assortment of grades, sizes and finishes.

You're sure, too, of stainless wire that is structurally sound and uniform in hardness, sufficiently ductile to make forming easy, and with proper physicals to meet your specifications.

Crucible has the right wire for your job. Your nearby Crucible representative will be glad to arrange for fast deliveries. Tell him your needs. *Crucible Steel Company of America, The Oliver Building, Mellon Square, Pittsburgh 22, Pa.*

CRUCIBLE first name in special purpose steels

Crucible Steel Company of America

Canadian Distributor—Railway & Power Engineering Corp., Ltd.

This handsome bakery oven is manufactured by Petersen and incorporates Jeffrey conveyor chain.

Petersen Oven Co. says,

"Since we mechanized our first oven 28 years ago, we've used **JEFFREY CHAIN**"

The best evidence of the quality of a product is the company it keeps. Jeffrey points with pride to this report on 28 years of close association with Petersen Oven Company of Franklin Park, Illinois.

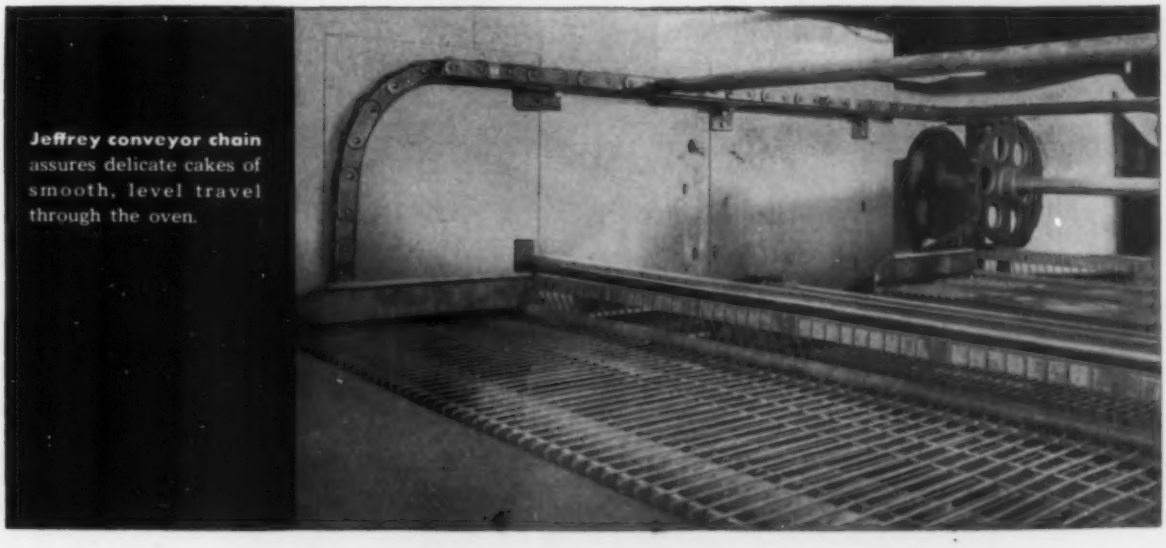
Jeffrey conveyor chain is employed on Petersen's ovens. It carries bread and cake through the ovens with a care that pleases the most discriminating baker. No tilting or jarring to cause even the richest cake to fall.

Jeffrey makes chain for almost every conveying and power transmission purpose. Our engineers will be pleased to assist in choosing the right chain for your task.

THE JEFFREY MANUFACTURING COMPANY • Columbus 16, Ohio

JEFFREY

CONVEYING • PROCESSING • MINING EQUIPMENT
TRANSMISSION MACHINERY • CONTRACT MANUFACTURING



Jeffrey conveyor chain assures delicate cakes of smooth, level travel through the oven.

FIGHT VIBRATION WITH VIBRATION

New twist in testing ...a torsional exciter

TORSIONAL testing *has* been done with rectilinear motion shakers by applying ingenuity in linking table to specimen. But here's a new MB exciter that produces torque *directly*. Its performance characteristics permit you to use it as a *calibrator* for torsional pickups and accelerometers . . . as well as for testing gyros and relays (as examples), or checking torsional vibrations of armatures, or determining torsional modes in various rotating parts.

OPERATING FACTS

At free-table, no load, this MB Model CA 1050 Exciter oscillates at up to 1600 cps without resonance in moving elements. It develops 110 ft. lbs torque, which produces angular accelerations as high as 1570 radians/sec/sec. Maximum total displacement is 45.°

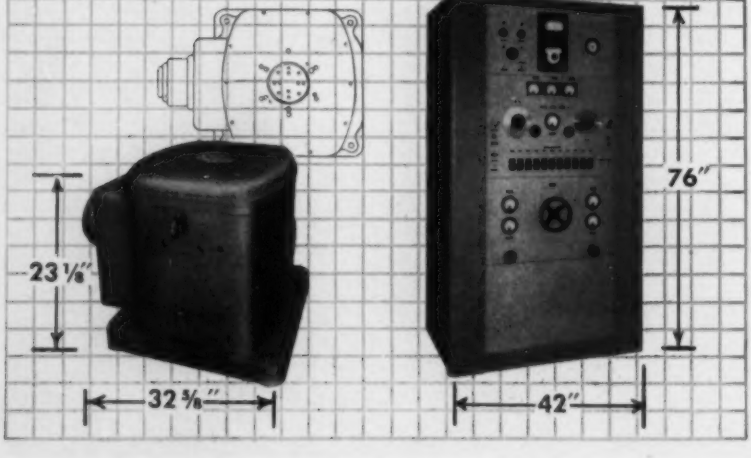
A MATCHED SYSTEM

Any one of several MB electronic power supplies drives the equipment, depending on the specific frequency range, power, and performance you want. The MB Model T51 Power Supply shown comes with automatic cycling controls if desired.

SEND FOR DETAILS

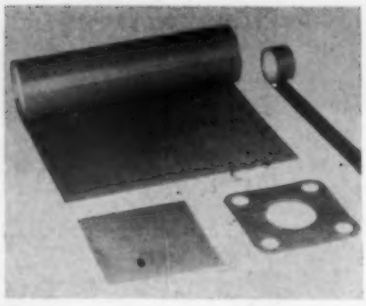
Technical data available. And for more information on how and where to use this unusual equipment, contact our staff of vibration specialists. You can't come to a better qualified authority on the subject . . . nor to one more willing to help on your specific vibration testing problems.

MB *manufacturing company*
A DIVISION OF TEXTRON INC.
1076 State Street, New Haven 11, Conn.
HEADQUARTERS FOR PRODUCTS TO ISOLATE . . . EXCITE . . . AND MEASURE VIBRATION



It is flexible down to −100 F, heat resistant up to 500 F, excellent aging and weathering qualities, good resistance to charring and abrasion. This sponge silicone material is available in sheet thicknesses from 1/8 through 1/2 in. and an extruded round cross-section size from 1/4 to 3/4 in. dia. Garlock Packing Co., 402 Main St., Palmyra, N.Y.

For more information—
Circle 111, inside back cover



Glass Fiber-and-Teflon Fabric

This combination of Teflon and glass fiber is available in tapes, sheets and rolls up to 38 in. wide, in 0.003, 0.005, 0.010 and 0.015 in. thickness. The manufacturer also offers it in fabricated form, in belts, pads or other shapes, produced by die cutting, heat welding, or stitching with Teflon thread. Chicago Gasket Co., 1271 W. North Ave., Chicago 22, Ill.

For more information—
Circle 112, inside back cover

Zinc-Clad Aluminum

Fabricated with one or both sides clad, and in coil or flat sheet form, this product is expected to provide aluminum sheet with ease of solderability. Aluminum Co. of America, 1501 Alcoa Bldg., Pittsburgh 19, Pa.

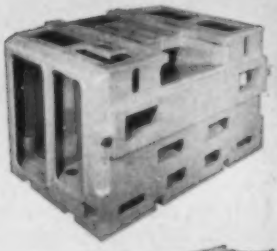
For more information—
Circle 113, inside back cover

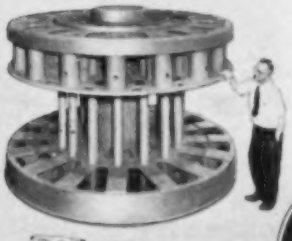
Plastic Bonding Agents

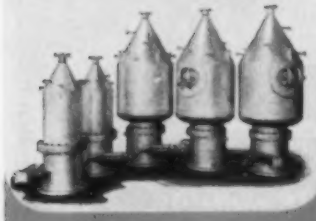
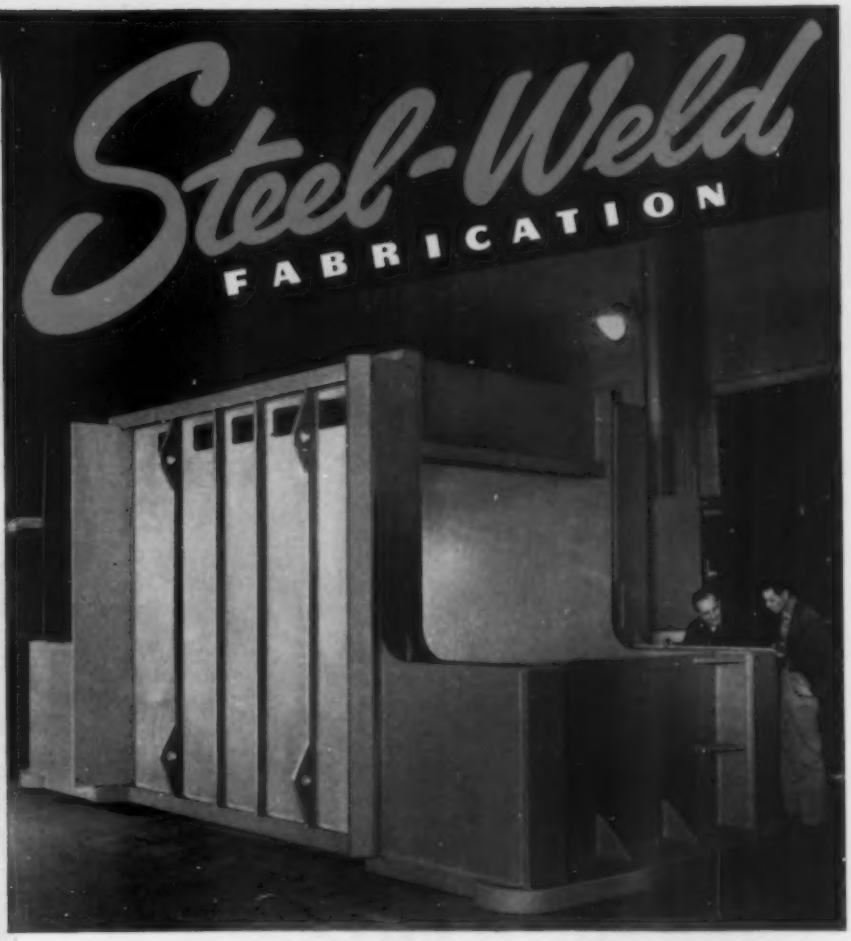
Impact resistant bonds to practically all metals, plastics, wood, glass, concrete and other surfaces are said to be possible with these adhesives, designed to replace other fastening methods such as welding, soldering,

(Continued on page 334)

Steel-Weld
FABRICATION





Use WELDED STEEL for Greater Strength with Less Weight!

The large weldment above is a 40-Ton Blank Holder for a 1000-Ton Press . . . this piece, and those illustrated at the left, are typical of thousands of Steel-Weld Fabricated parts and assemblies produced by Mahon for manufacturers of processing machinery, machine tools, and other types of heavy mechanical equipment. Are you taking full advantage of the possibilities offered by welded steel components in your product? In the design of almost any type of heavy machinery there are parts and sub-assemblies that can be produced more economically and more satisfactorily in welded steel, because, in weldments you get greater strength with less weight, plus the additional advantages of greater rigidity and predictability. If you are considering weldments, you can call on Mahon with complete confidence, because, the Mahon organization is a unique source for welded steel in any form . . . a reliable and responsible source with complete facilities for design engineering, fabricating, machining and assembling . . . a source where design skill is supplemented by craftsmanship which assures you a finer appearing product embodying every advantage of Steel-Weld Fabrication. See Sweet's Product Design File for information, or, better still, have a Mahon sales engineer call at your convenience.

THE R. C. MAHON COMPANY • Detroit 34, Michigan

Sales-Engineering Offices in Detroit, New York and Chicago

Engineers and Fabricators of Steel in Any Form for Any Purpose

MAHON

7 *ways to better whiteprints...*

on the new printmaster 810

Here's the brand new Printmaster 810—with 7 big new operating features. They make your printmaking easier, more fool-proof than ever before!

1. New air flow system for better print pickoff
2. New diaphragm ammonia pump for top uniformity in developing
3. New cartridge heater for greatly improved development at high speeds
4. New phenolic "fingers" to pick off tracings without tearing
5. New protection sheet and suction baffles to keep originals safe
6. New feeder brushes to flatten curl in rolled tracings
7. New tracing receiving system to handle cut sheets and rolled tracings, both!

And that's not all. Incorporated into the "810" are such *proven* Ozalid advances as the electronic drive . . . low temperature cooling system . . . exclusive blower-timer and U/L approved safety devices. *Why not test run your own tracings through the new "810"? Simply call your local Ozalid representative. His number's in the phone book, or write: Ozalid, Dept. BBO-3, Johnson City, N. Y.*

A Division of
General Aniline &
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In Canada:
Hughes Owens Company Ltd.,
Montreal

OZALID®

First name in whiteprinting

Helpful Data from
DE LAVAL

How to calculate the efficiency of worm gearing

The efficiency of worm gearing is determined by frictional losses at the tooth contact, bearings and oil seals plus losses from oil churning and windage. A formula for efficiency at the tooth contact may be developed from a consideration of the forces at the contact. Figure 1 shows these forces acting on a developed section of the worm thread. For simplicity the pressure angle has been assumed to be zero.

The coefficient of friction of the worm and gear is a function of the materials, finish, lubrication and rubbing speed. The latter is the relative speed between a point on the pitch surface of the gear and one on the pitch surface of the worm. The coefficient of friction varies very little at high rubbing speeds but rises with increasing rapidity as the speed drops below 500 fpm.

The efficiency formula developed in Figure 1 involves worm lead angle and the friction angle. Figure 2 provides a relationship between friction angle and rubbing speed based on tests made on accurately manufactured gearing consisting of hardened and ground worm and bronze gear operating in oil.

The formula for rubbing speed is:

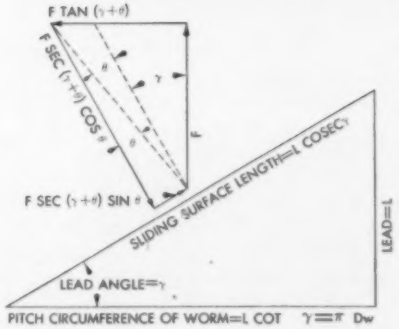
$$V = \frac{.262\ Dw \times \eta}{\cos \gamma}$$

where

V = Rubbing speed – feet per minute
Dw = Worm pitch diameter – inches
η = Worm speed – rpm
γ = Worm lead angle

FIGURE 1.

Development of equation for efficiency at contact between worm and gear



F=TANGENTIAL FORCE ACTING ON GEAR

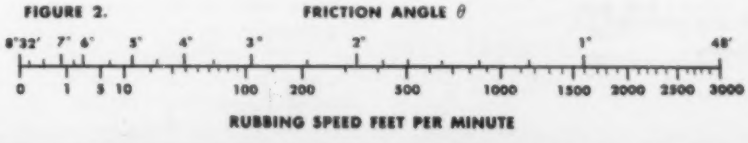
F TAN ($\gamma + \theta$) = TANGENTIAL FORCE APPLIED TO WORM

F SEC ($\gamma + \theta$) COS θ = FORCE NORMAL TO CONTACT SURFACE

F SEC ($\gamma + \theta$) SIN θ = FRICTIONAL FORCE

$$\text{EFFICIENCY} = \frac{\text{WORK REALIZED}}{\text{WORK APPLIED}} = \frac{L \times F}{L \cot \gamma \times F \tan (\gamma+\theta)} = \frac{\tan \gamma}{\tan (\gamma+\theta)}$$

FIGURE 2.



DE LAVAL Worm Gear Speed Reducers Offer Efficiencies to 96%

Ruggedly built for long efficient service De Laval speed reducers are made in horizontal and vertical single reduction units in ratios of 3:1 to 100:1. They are also available in double horizontal and vertical double reduction units as well as in helical-worm and double-worm design. Ratios from 37.8:1 up to 6400:1.

Write for your copies of Catalogs G-WBV and G-WWH to De Laval Steam Turbine Company, Trenton 2, New Jersey.

Best low-cost way to incorporate variable-speed into machine designs

Choose from 8 sizes . . . ¼ to 15 hp . . . 1.75:1 to 4:1 speed ratio. Converts any standard constant-speed motor into variable speed drive.
MAXIMUM TO MINIMUM OUTPUT SPEED POSITIONS

REEVES®

Vari-Speed Motor Pulley

Specify this easy, economical way to efficient and versatile use of the machines you design. REEVES-equipped machines adjust immediately to a variety of production speeds, production processes . . . you substantially reduce design and capacity obsolescence.

Your REEVES representative will be glad to work with you on the application best suited to your design. Offices in principal cities—or write direct for Catalog K28a-V545.

REEVES PULLEY COMPANY
Division of RELIANCE ELECTRIC AND ENGINEERING CO.
Columbus, Indiana

riveting and bolting. They are also suitable for filling cracks, sealing, patching, caulking seams and other applications where a heavy build-up is necessary. H. B. Fuller Co., 181 W. Kellogg Blvd., St. Paul, Minn.

For more information—Circle 114, inside back cover

Flexible Magnetic Tape, Rod and Shapes

A flexible ferromagnetic plastic is made in rod and tape form. Rod sizes are $\frac{1}{8}$, $\frac{3}{32}$ and $\frac{1}{4}$ in. dia. The tape is $\frac{1}{2}$ in. wide and stocked in thicknesses 0.004, 0.008, 0.016, 0.032 in. Polymer Corp. of Pa., 2140 Fairmont Ave., Reading, Pa.

For more information—Circle 115, inside back cover

Expanded Metal with Extra-Small Openings

This expanded metal is available with openings as small as $\frac{1}{16}$ in. Diamond shapes at present are the basic pattern for expanded metal. In the development stage are square and tear drop openings.

Expanded metal can be produced from aluminum, steel, stainless steel, copper, brass, Monel. Designers Metal Corp., 567 E. 159 St., Harvey, Ill.

For more information—Circle116, inside back cover

Electric Contact Materials

These materials are composed of a thin contact surface of precious metal metallurgically bonded to an inexpensive base metal. They are available in five varieties of clad strip, as well as in the popular button or disc forms.

Silver is the most widely used contact material, but where tarnish-resist-

(Continued on page 338)

FACE IT!

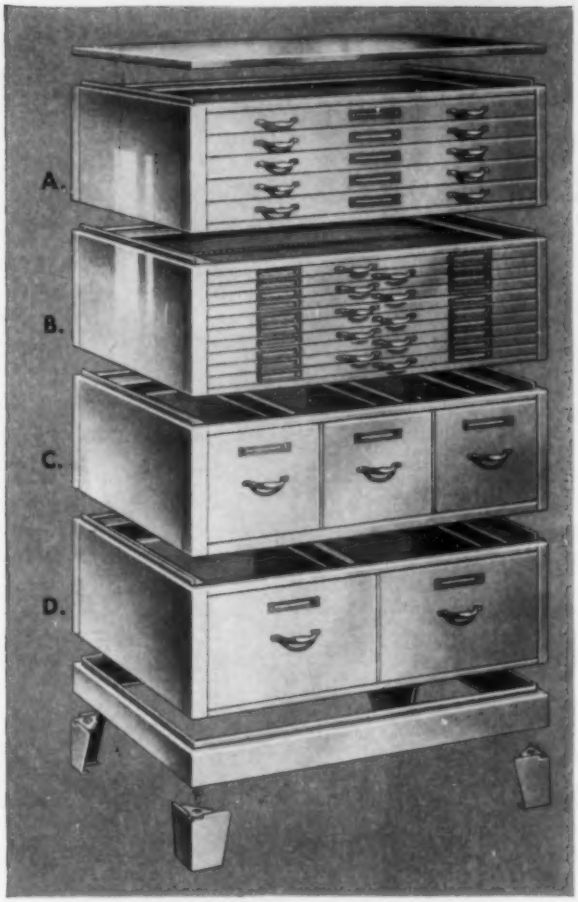
Right Now Is the Time to Eliminate Haphazard Filing, Save Time and Space with a Hamilton UnitSystem!

The boom in production means more pressure for drafting room output . . . more pressure on you for filing time and space. Right now is the time to replace those old, inadequate files you've been putting up with—now's the time to get a modern Hamilton UnitSystem from Bruning.

With UnitSystem, you file drawings and records in units especially designed for them by size and frequency of use. Drawings are easier to file and find, which saves time. UnitSystem's interlocking feature lets you combine exactly the units you need—in higher stacks—which saves space. It lets you expand your filing set-up gradually, efficiently, and economically.

One unit (A) has five deep drawers to provide ideal storage for semi-active or inactive drawings and records. Shallow-Drawer Unit (B) with special tracing lifters makes any active tracing easily accessible without risk of damage to companion tracings. Vertical Filing Units (C-D) with index binders and compressors keep active small sheets upright without wrinkling.

Act now to gear your filing to the growing demands of the production boom. Mail coupon today.



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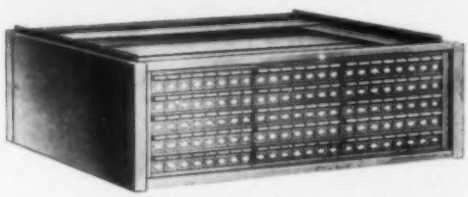

File units for roll tracings are available. Individual trays protect each roll from dirt, tearing, and crushing.

CHARLES BRUNING COMPANY, INC. • CHICAGO

In Canada: Charles Bruning Co. (Canada) Ltd., 105 Church St., Toronto 1, Ont.

Charles Bruning Company, Inc., Dept. 34-0
4700 Montrose Avenue, Chicago 41, Illinois

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☐ Send me information on the Bruning-Hamilton free analysis and planning service.

Name_____ **Title**_____

Company_____

Address_____

City_____ **County**_____ **State**_____

BRUTE STRENGTH FOR BIG ASSEMBLIES—

Cleveland large diameter upset forged socket head cap screws

On big presses, extrusion machinery, and earth moving equipment, fasteners not only have to support massive static loads; they must also withstand the dynamic stress of heavy impact, shock and vibration.

Engineered specifically for this type of service, Cleveland large diameter socket head cap screws are upset forged from specially heat-treated alloy steel. The forging process shapes the steel so that grain flow follows the contour of the head; eliminates planes of weakness along which shear might occur under dynamic stress; and protects assemblies against fastener fatigue failure.

In large diameters we regularly stock 1¼-7 and 1½-6 through 12 in. for same-day shipment. For other standard sizes from 1⅛ to 3 in. diameter through 12 in. length, we have the stock and the tooling to produce your order quickly.* For prompt service, contact your local Cleveland distributor. He can also supply large diameter upset forged hexagon head cap screws.

*Diameters over 3 in., lengths over 12 in., available on special order.

New folder gives dimensions (including old and new head details), physical properties, weights, prices of Cleveland large diameter socket head cap screws. Write for copy today.

THE CLEVELAND CAP SCREW COMPANY
4444-4 Lee Road, Cleveland 28, Ohio
WAREHOUSES: Chicago • Philadelphia • New York • Providence • Los Angeles

OVER-DESIGNING?

If you are designing bronze parts for mass production, there is a good chance that you are specifying a more costly alloy than you need.

ASARCO's patented continuous-casting process produces alloys according to SAE, ASTM and Government specifications. But their performance is entirely unlike that of similar alloys cast in sand or permanent molds. Relatively low-cost alloys cast by the ASARCO process perform like more expensive alloys cast by other methods.

For example, compare Continuous-Cast SAE 660 (ASARCON 773) with more expensive sand-cast alloys:

	Typical Yield Strength	Typical Impact Strength	Brinell Hardness
ASARCON 773	27,000 psi	12.5 ft.-lbs.	72
Sand-Cast SAE 62	20,000 psi	8.7 ft.-lbs.	65
Sand-Cast SAE 64	17,000 psi	8.2 ft.-lbs.	62

Unless you've checked to see whether the unique ASARCO bronzes can give you what you need, there's a possibility that you're over-designing. You may even be able to replace aluminum and manganese bronzes with low-cost ASARCON Continuous-Cast bronzes under certain conditions. Over-designing can be expensive in mass production, even if you are spending only a penny or two extra per pound of bronze.

ASARCON 773 (SAE 660) is readily available from stock in a wide range of sizes. An added bonus is the fact that ASARCON 773 is exceptionally free-machining. Rods, tubes, and numerous "extruded" shapes up to 9 inches in diameter are cast to order by ASARCO in more than 20 alloys.

We'll be happy to send you a free booklet describing the process and the product.

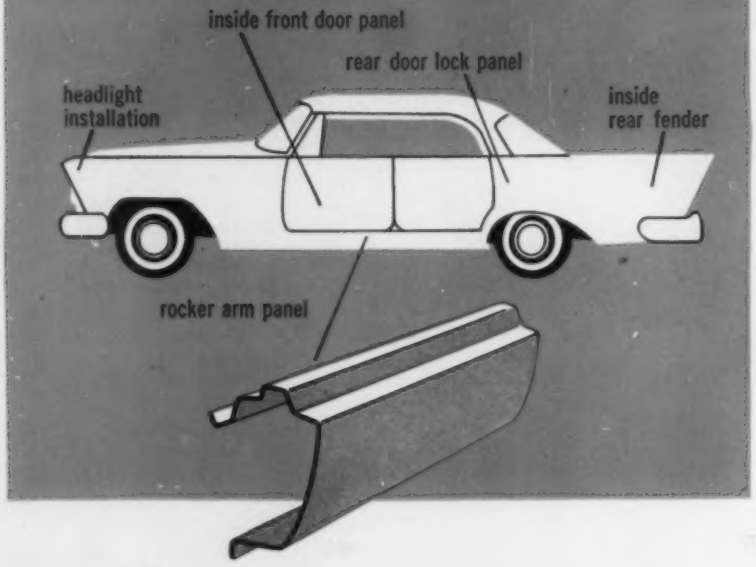
Continuous-Cast Products Department

AMERICAN SMELTING AND REFINING COMPANY

Perth Amboy Plant, Barber, New Jersey • Whiting, Indiana

WEST COAST SALES AGENT: Kingwell Bros. Ltd., 457 Minna Street, San Francisco IN CANADA: Federated Metals Canada, Ltd., Toronto and Montreal

NOW! a weldable
corrosion-resistant coating
Zincilate 400



IT'S NEW! Zincilate 400 was used first by the automotive industry on the late 1956 models.

IT'S PROVED! Zincilate 400 is now being used by more manufacturers, in more crucial areas, on the 1957 models.

IT'S EXCLUSIVE! Only Zincilate 400 can be applied before fabrication, then welded, minutes or months after application. You'll get fast, clean work — anytime — when you weld over a Zincilate 400 coating, because it retains its conductivity and contains no chemicals to contaminate electrodes. And, note this — Zincilate 400 provides galvanic protection, even at the point of burn-off, that keeps corrosion shackled.

You can use Zincilate 400 on your product, applying it as the automotive people do, by spray, brush or dip, before fabrication and welding. Your product, if it's made of metal, will be protected — always — by Zincilate 400.

Cost? You'll find many coatings with a lower first cost. But overall costs, where it really counts, are lowest when you're using Zincilate 400. If you'll outline your problem, we'll be happy to tell you just what you can expect of Zincilate 400—and there's no obligation.

Zincilate

CORROSION-RESISTANT, ABRASION-RESISTANT, WELDABLE, AIR-DRIED and BAKED PROTECTIVE COATINGS

INDUSTRIAL METAL PROTECTIVES, INC., 404 HOMESTEAD AVE., DAYTON 8, OHIO

ing characteristics are specified, surface claddings of gold, platinum, palladium and their alloys are supplied. Steel is a common base metal. Gages ranging down to ultra-thin, rolled to precision tolerances, are now in production. American Silver Co., Inc., 36-07 Prince St., Flushing 54, N.Y.

For more information—
Circle 117, inside back cover

Silver-Cadmium Oxide Contacts

Contacts are available in fabricated parts and strip form. Silver-cadmium oxide top-lay is made in clad strip widths of $\frac{1}{16}$ to $4\frac{1}{2}$ in. and in base metal thickness from less than 0.010 to 0.250 in. or more. The silver-cadmium oxide metal on the contact section of top-lay will usually vary from about 0.015 x $\frac{1}{8}$ in. wide, min, up to any practical maximum dimension. General Plate Div., Metals & Controls Corp., Attleboro, Mass.

For more information—
Circle 118, inside back cover

ENGINEERING DEPT. EQUIPMENT

Speed Reducer Kits

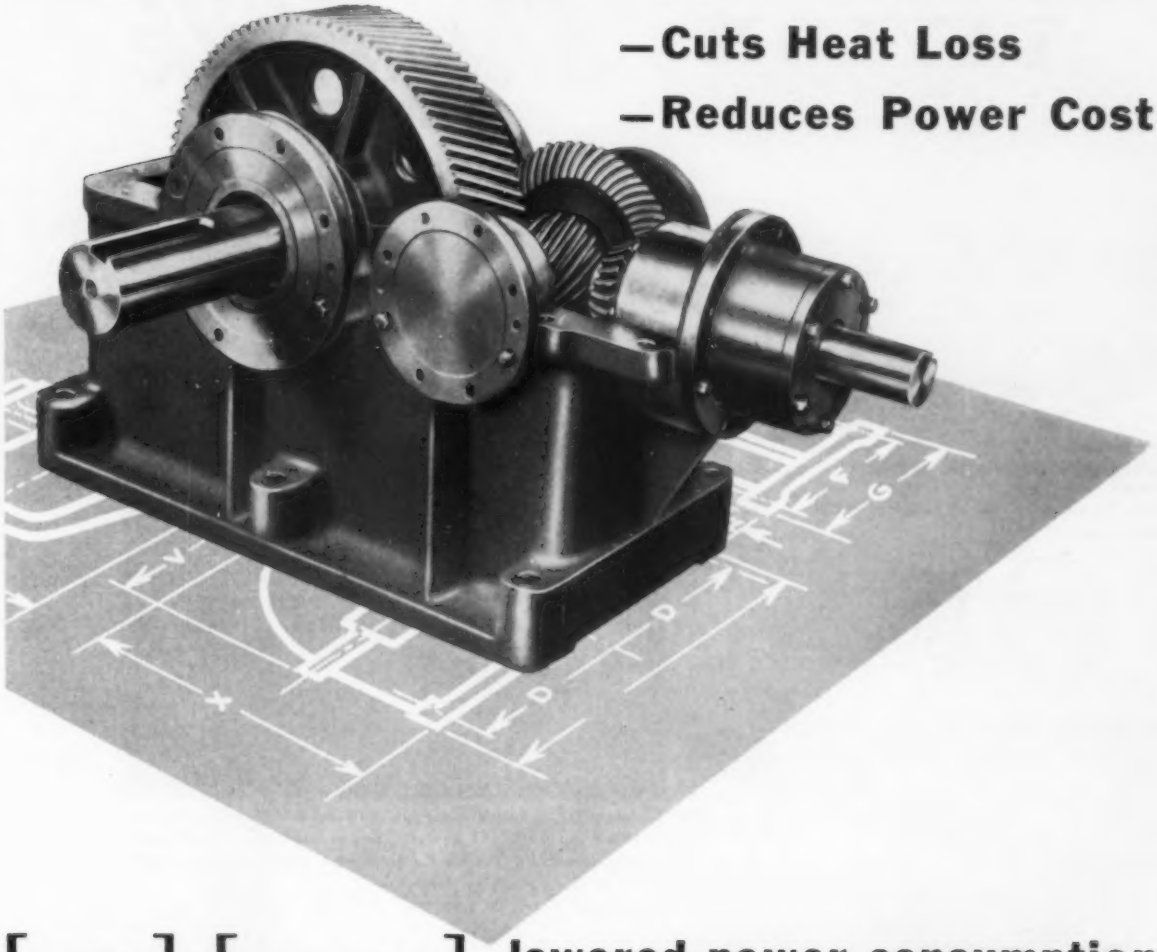
The speed reducer is designed for re-use, allowing assembly and disassembly to component hangers, with a complete range of ratios. All units come assembled in a felt-lined case with associated hardware, such as

(Continued on page 342)

Maximum Efficiency In Right Angle Drives

—Cuts Heat Loss

—Reduces Power Cost



[advanced design] + [manufacturing skill] = lowered power consumption and reduced prime-mover cost

A glance at the illustration will readily convince you of the plus features of these quality "custom-built" units. Spiral-Bevel and Helical Gearing assures quiet operation at high speeds, and increased tooth strength. Pinion shafts are integral with gears and finished to close tolerances by grinding. Ball or Roller Bearings support shafts and are designed to take combined radial and thrust loads. Housings are quality grey cast iron with all points of stress properly ribbed to reduce deflections and stresses to minimum; also housing design provides adequate oil reservoir and large radiating surface for thermal capacity. Vertical Units are also available, and are equipped with "dry well", which keeps oil from leaking at low speed shaft.

Hundreds of Philadelphia Spiral-Bevel Helical Units are used throughout Industry, driving Paper Mill Machinery, Conveyors, Blowers, Fans, Machine Tools.

Philadelphia Spiral-Bevel Reducers may be had in Horizontal or Vertical Types; Single, Double or Triple Reduction types, to meet every possible requirement.

Send for complete Catalog #SB-57, which describes all types of Horizontal and Vertical Spiral-Bevel Helical Units.

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TAYLOR Laminated Plastics Vulcanized Fibre

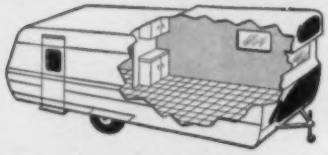
Shop Talk

TAYLOR FIBRE CO.

Plants in Norristown, Pa. and La Verne, Calif.

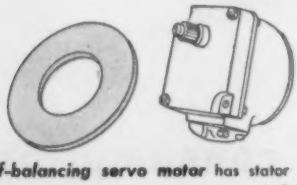
PHENOLIC—MELAMINE—SILICONE—EPOXY LAMINATES • COMBINATION LAMINATES • COPPER-CLAD LAMINATES • VULCANIZED FIBRE

Tips for designers

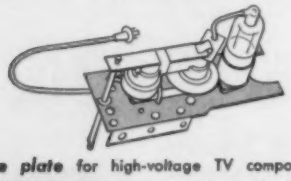


House trailer interior walls are made of plywood faced with Taylor vulcanized fibre, chosen for its combination of light weight and high strength.

Highway signs use Taylor Grade XX phenolic tubing and washers that are long-wearing and do not rust.



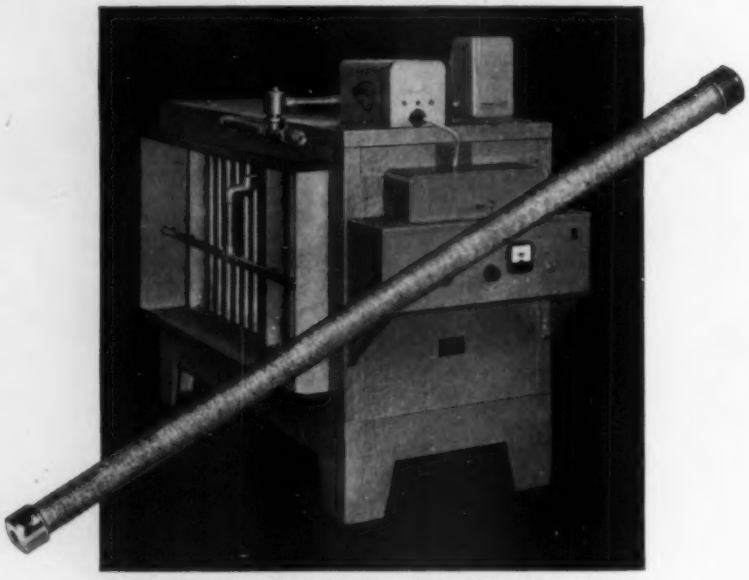
Self-balancing servo motor has stator case insulator which is cold-punched from 1/64" thick Taylor Paper Base Phenolic Laminate sheet.



Base plate for high-voltage TV component, punched from Taylor canvas melamine laminate, has high dielectric strength and arc resistance.

NEW TAYLOR COPPER-CLAD LAMINATES

Taylor GEC (glass epoxy) Copper-Clad and Taylor XXXP-242 cold punching (paper-phenolic) Copper-Clad. Taylor uses high purity rolled copper on base materials with outstanding electrical properties.



A selenium "pencil" rectifier made by Union Switch & Signal for an electronic air cleaner, by Electro-Air Cleaner Co., uses an outer tube of Taylor Grade G-5 laminated plastic. The material has excellent arc-resistance, mechanical properties and low moisture absorption.

Taylor Melamine Laminate solves material selection problems

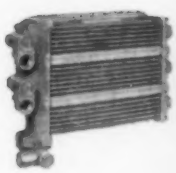
The pencil-thin outer case of this selenium rectifier presented several unique problems. It required a new concept of high arc-resistance, plus mechanical strength and low water absorption. Taylor Grade G-5 (glass-melamine) laminate solved these problems . . . embodied both the electrical and mechanical properties required for the outer tube. The broad selection of Taylor laminates includes a wide variety of different bases and different grades, each with certain combinations of electrical and physical properties to answer your materials selection problems.

In any application, Taylor laminates bring you important savings in fabrication. Whether you need tubes, rods, sheets or fabricated parts, Taylor laminates come in sheets 49" by 49" . . . tubes with inside diameters as small as 3/32" up to 36", lengths to 49" and a variety of wall thicknesses . . . rods in a wide range of sizes. Or, Taylor can fabricate your part to your specifications . . . on time and at a saving.

To help you choose and use the right laminate, Taylor's engineering staff and fabricating facilities are at your service. Contact your nearest Taylor sales engineer.

TROPIC HEAT

OR ARCTIC COLD



Harrison Heat-Exchangers Keep Temperatures Level!

Harrison goes to any extreme to keep temperatures on the beam . . . to keep temperatures normal under all types of operating conditions! These top-quality heat-exchangers are busy everywhere —on land, on sea, and in the air . . . guarding critical engine temperatures and providing safe, sure performance. They're lightweight and compact, too—designed to save you space and money. That's why Harrison is a leader in its field—that's why so many manufacturers rely on Harrison *exclusively* for dependable, economical heat-transfer equipment. If *you* have a cooling problem, look to Harrison for the answer.

GM GENERAL MOTORS

HARRISON RADIATOR DIVISION, GENERAL MOTORS CORP., LOCKPORT, N. Y.

Watch WIDE WIDE WORLD Sundays on NBC-TV

HARRISON

TEMPERATURES MADE TO ORDER

designed to give you

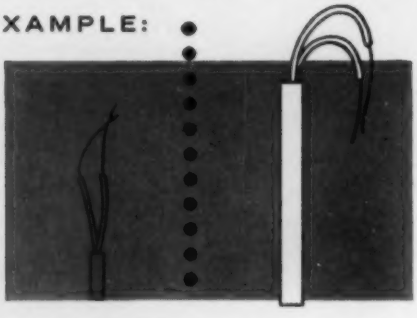
AS MUCH HEAT IN 1/5 THE SPACE!

NEW WATLOW FIREROD®

CARTRIDGE HEATING UNIT

a new high in watts densities and temperatures

FOR EXAMPLE:



The FIREROD can be rated at 368 watts/ sq. in. while operating in a steel block at 500° F. with a fit of .005. At this watts density, a unit 1/2" O. D. x 2-1/4" would have a rating of 1000 watts.

The Firerod gives you amazing concentration of heat in a small cartridge heating unit. So much in so little space means new design flexibility for many applications.

Pat. Pending

Units are available in lengths from 7/8" to 12", diameters of 3/8" and 1/2",

For convincing test-proof and other data, write for new FIREROD BULLETIN #360

WATLOW ELECTRIC MFG. CO.

SINCE 1922—DESIGNERS AND MANUFACTURERS OF ELECTRIC HEATING UNITS

1392 FERGUSON AVE.

SAINT LOUIS 14, MO.

couplings, cleats, screws and tools.

The U4 kit has a 1¾ in. OD. The U5 kit has a 1⅞ in. OD. Both kits have six speed reducers and an additional 31 component parts. Pic Design Corp., Div. Benrus Watch Co., Inc., 477 Atlantic Ave., E. Rockaway, N.Y.

For more information—
Circle 119, inside back cover

Rotary-Scale Volt-Ammeter

This instrument, with a built-in recessed range selector, permits selection of any one of four ampere and two voltage ranges by just a flick of the thumb. Only one current or voltage scale is visible at any time. The instrument can be used for balancing circuits, tracing faults and grounds, in estimating new or revised distribution circuits, diagnosing operating trouble without shutting down equipment or premises. Pyramid Instrument Corp., Lynbrook, N.Y.

For more information—
Circle 120, inside back cover

Plots Points Along Coordinates

This instrument plots points along X and Y coordinates within 0.001 in. and is used for aircraft lofting, gage charts, and laying out small parts. It is also used to plot blades in a stack or flow patterns for turbine blades, to establish coordinated positions precisely for chart and map makers, and to plot reticules or targets for instrument manufacturers. The working area is a 47½ x 47½ in. table, made of vertically laminated wood strips. Radii from 12 to 40 in. can be plotted. The

(Continued on page 346)

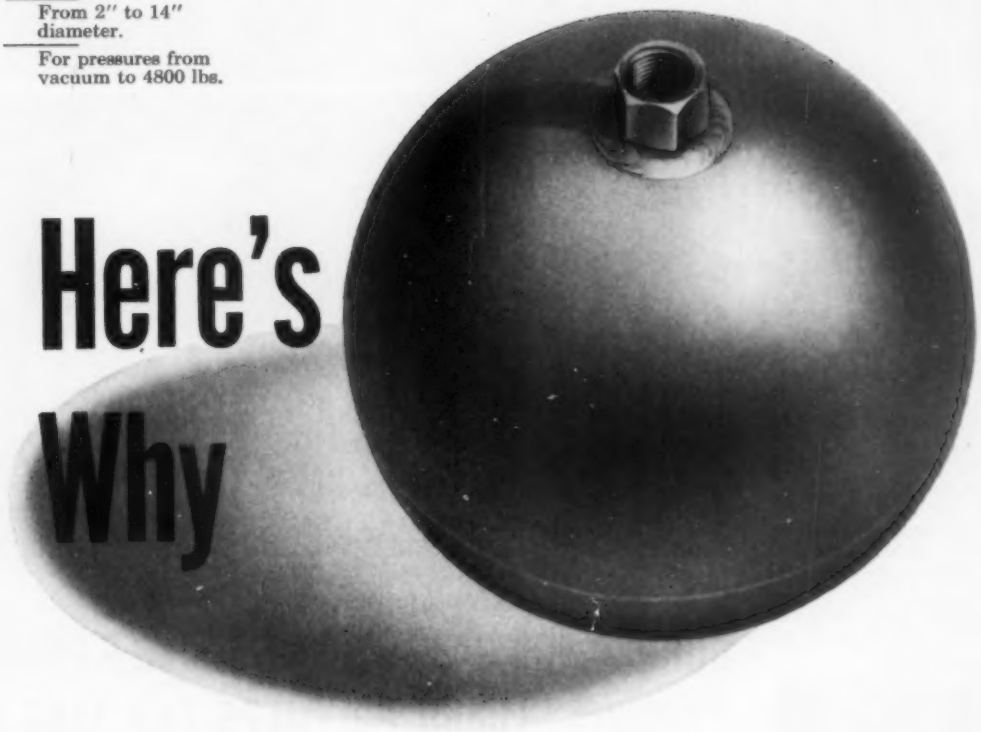
Available in
Stainless Steel
Plated Steel
Monel

Spherical
Elliptical
Cylindrical

From 2" to 14" diameter.

For pressures from vacuum to 4800 lbs.

Here's Why



Nicholson precision welded floats are better, last longer

No mere thin-walled copper floats, these—but high tensile strength precision welded steel floats with extraordinary resistance to pressure and corrosion! Nicholson Floats give you such outstanding advantages as—

Die-formed float halves with inward rolled edges—not spun, laminated or electrodeposited;

Uniform wall thickness—float halves annealed after draws to prevent cracking;

Butt-welded seams—forming a reinforcement ring, to give floats greater resistance to external pressure.

Steel floats can be supplied—in quantity—with chromium, cadmium, or copper plating . . . or with sand-blast or pickled finish. Stainless steel and Monel floats can be furnished—in quantity—rough-buffed, polished, or with welds ground smooth and highly finished for easy sterilization and cleaning.

Nicholson can deliver precision welded floats to fit your production schedule. Today, thousands of Nicholson Floats are in service—most as buoyancy mediums . . . many as fluid chambers and pressure vessels, as well. Write for details about the complete Nicholson line.

NICHOLSON

W. H. NICHOLSON and Company

FLOATS • TRAPS • VALVES • METAL PARTITIONS
LAUNDRY, DRY CLEANING AND PRESSING MACHINERY

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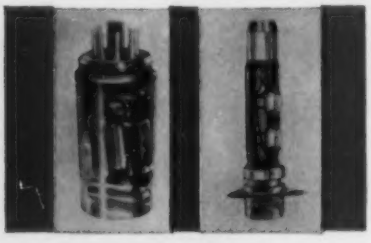
Thiokol

PRODUCT DEVELOPMENT NEWS

New Method For Protecting Electronic Components

Sensitive electronic components are now protected from vibration and other causes of failure by imbedding them in elastomeric alloys of "Thiokol" Liquid Polymer and epoxy resins.

These new "Thiokol" Polymer-modified epoxies provide superior impact strength, better resilience, less cure shrinkage and lower heat rise than straight epoxy resins, yet they retain all the basic epoxy advantages such as high strength, chemical resistance, good electrical characteristics, and excellent adhesive properties. What's more, their properties can be altered and new ones developed merely by varying the ratio of "Thiokol" Liquid Polymer to epoxy resin.



NEW ELASTOMERIC ALLOYS of "Thiokol" Liquid Polymers and epoxy resins help protect these sensitive electronic components.

Protective encapsulation of electronic components is only one of many vital new uses for versatile "Thiokol" Polymer/epoxy alloys. Others include applications as adhesives, laminates and coatings and a wide and growing range of uses in the plastic tooling and sealing fields.

Check the five key properties listed below and see where these versatile alloys fit into *your* product plans. Complete information on their properties and potentialities will be furnished on request.

New elastomeric alloys provide:

- Resilience and impact strength
- Lower shrinkage
- Room temperature cures
- Improved working properties
- Excellent temperature cycling

SEALING COMPOUND based on "Thiokol" Liquid Polymer is applied to jet fighter bubble to produce durable, vibration-proof seal. (Minnesota Mining & Mfg. Co.)

RUGGED AIRCRAFT SEALING CHORES PROVE "THIOKOL" LIQUID POLYMERS CAN TAKE IT

Tight seals are maintained despite vibration, solvents

Hurtling through the air at hundreds of miles per hour, today's planes put materials through the toughest of tests.

Sealants for cabins, windows and windshields, for example, must stand up under terrific pressures, must remain resilient while temperatures rise and fall. Sealants for integral wing tanks must take prolonged exposure to aviation fuels and still maintain strong, tight seals in spite of severe vibration, contraction and expansion.

To meet such exacting demands, aircraft manufacturers specify sealing compounds based on "Thiokol" Liquid Polymers.

Just what are these polymers?

"Thiokol" Liquid Polymers are synthetic rubbers in liquid form that cure to solid rubbers without shrinkage at normal working temperatures. Once cured, they remain firm and rubbery at temperatures ranging from 65° below to 275° above zero. They adhere tenaciously to metal, glass, wood, plastics and many other materials, are unaffected by ozone, sunlight, oxidation and weathering, and display outstanding resistance to solvents, oils and many chemicals.

In aircraft sealing, "Thiokol" compounds are extruded in place to form solvent-proof, age-resistant gaskets. They flow into openings and irregularities and produce tight, leak-proof seals that lock in fuel and prevent loss of cabin pressure.

Potential uses unlimited

Though aircraft sealing is one of the more dramatic "Thiokol" applications, other uses for these versatile polymers are discovered almost every day. Liquid Polymers are now used in making poured-in-place gaskets, sealing electrical components, impregnating leather, caulking ships, casting molds, patterns and printers' rolls and even in weather-proofing buildings.

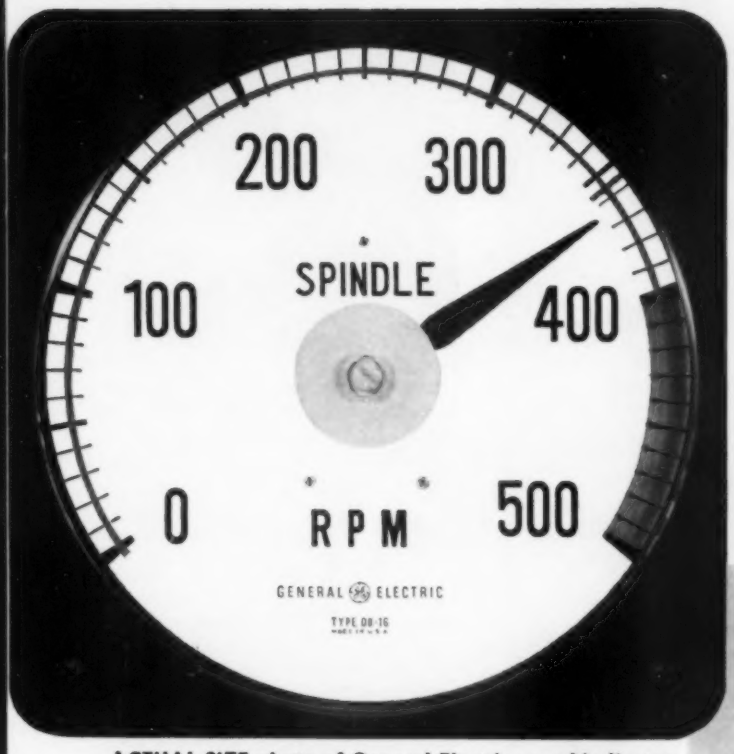
No doubt some of your products can benefit from the durability and adaptability of "Thiokol" Liquid Polymers. For technical information and samples, write: THIOKOL CHEMICAL CORPORATION, 784 NORTH CLINTON AVE., TRENTON 7, N. J. In Canada: Naugatuck Chemicals Division, Dominion Rubber Company, Elmira, Ontario.

(Thiokol Chemical Corporation supplies "Thiokol" Liquid Polymer as a raw material. Sources of suitable compounds will be supplied on request.)

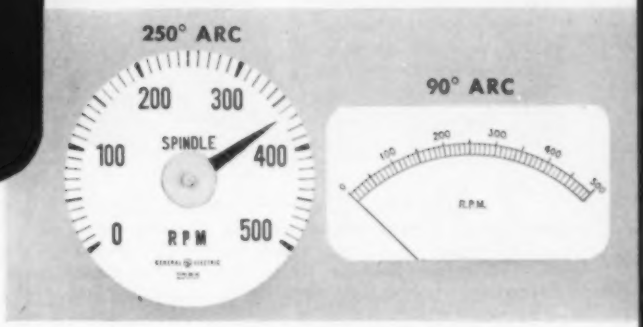
Thiokol®

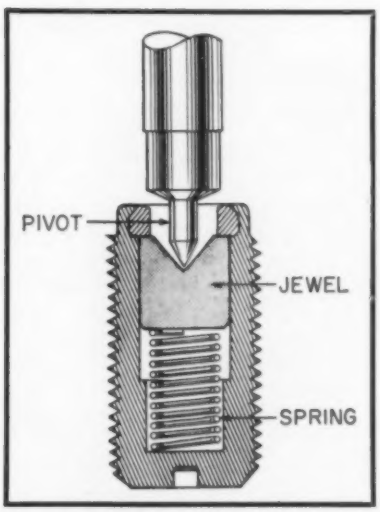
PIONEER MANUFACTURERS OF SYNTHETIC RUBBER

Unique features of General Electric Speed Measuring Systems Give Top Performance



ACTUAL SIZE photo of General Electric speed indicator shows ease of readability made possible by 250° scale, shadow-proof glass and large numerals. Design also available in large 8¾ inch instrument.





NEW DESIGN for sustained instrument accuracy utilizes spring-mounted jewels to cushion pressure on pivot points. Bevel-shouldered pivots ride against retainers to help protect against "mushrooming."

General Electric offers a complete line of a-c and d-c tachometer generators and indicators or recording instruments that provide features unmatched by other speed measuring equipment.

SHOCK RESISTING PIVOT DESIGN

Maximum ruggedness of General Electric speed indicators is assured by their special pivot and spring-mounted jewel design. This new construction practically eliminates pivot "mushrooming" and resultant sticky pointer action caused by vibration and shock incurred in high speed applications.

Any legend in any combination of colors you desire will be marked on your General Electric tachometer scales. Your instrument can be calibrated in units such as feet per minute, inches per minute, spindle rpm or any related speed. Manufacturer's or customer's name may also be imprinted on the scale face.

ACCURACY OF ±1%

All General Electric speed measuring systems are factory calibrated for an accuracy of ±1%. Any error that occurs in a-c systems due to rectifier aging can be eliminated by periodic adjusting of the rheostat at the base of the indicator, another exclusive General Electric feature.

For sustained accuracy, d-c instruments employ a permanent magnet, moving-coil mechanism. Instruments are thoroughly shielded to help prevent stray magnetic fields from affecting their accuracy. Both indicators and generators are totally enclosed for protection against dust and dirt. Explosion-proof enclosures are available on many generator models.

Less maintenance is required on General Electric a-c tachometer generators because they do not employ brushes or slip rings, thus eliminating friction. Small in size, these tachometer generators are ideal for applications where space is at a preminum.

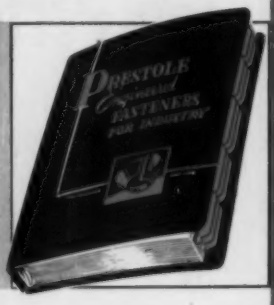
For more detailed information, call your nearest General Electric Apparatus Sales Office or write for Bulletin GEC-1258 to Section 585-71, General Electric Company, Schenectady 5, N. Y.

Progress Is Our Most Important Product

GENERAL ELECTRIC

more than
1,001
WAYS
for Engineers to
Solve Fastening Problems!

Your PRESTOLE representative has this volume of fastener information now—and will be glad to review it with you at your convenience.
See list below



PRESTOLE—designers and producers of precision-built, cost-saving, industrial fasteners of all types—has just completed a new volume of standard fastener data, designed to assist industrial design engineers in finding the *right* fastener for every application.

Complete, illustrated, specification-type data, based on years of fastening "know-how", is listed on every type of Prestole fastener available.

There is a method to solve any fastening problem . . . and Prestole has it! Let our representative call and show you how. No obligation, of course!

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CONNECTICUT—MANCHESTER Joseph Murphy • 908 Main St.
ILLINOIS—CHICAGO 39 Everett Bernardo 5625 W. Fullerton Ave.
MICHIGAN—DETROIT Frank J. Brady Co. 2405 W. McNichols
MISSOURI—ST. LOUIS 10 Edward: Sales Agency 3687 Market St.
NEW JERSEY—FAIR LAWN Electronic Sales Associates, Inc. 13-08 Merlot Ave.
NEW YORK—DE WITT 14 A. J. Murphy Co. P. O. Box 216
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CLEVELAND 22—Wm. C. First • P. O. Box 888
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PENNSYLVANIA—PHILADELPHIA 44 William J. Noonan, Jr. 38 Maplewood Ave.
TENNESSEE—CHATTANOOGA Peirson-Deakins Co. 823 Chattanooga Bank Bldg.
TEXAS—DALLAS 29 W. P. Schoenfield 4407 Northcrest Rd.
WASHINGTON—SEATTLE 8 Charles Industrial Sales Co. 5201 First Avenue, South
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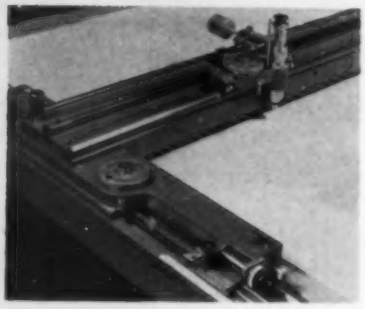


pricker point unit has a 7 x microscope, so that the point can be observed and plotted in a single set-up. Aero Service Corp., 210 E. Courtland St., Philadelphia 20, Pa.

For more information—
Circle 121, inside back cover

Measuring Magnifier

Used for on-the-spot checks for linear dimensions, diameters, radii and angles. Linear dimensions are given both in inches and millimeters. Reticule can be removed, making the unit a 6X magnifier. Light is admitted through transparent walls of the plastic cell. Edmund Scientific Co., Barrington 21, N.J.

For more information—
Circle 122, inside back cover

Pocket Adding Machine

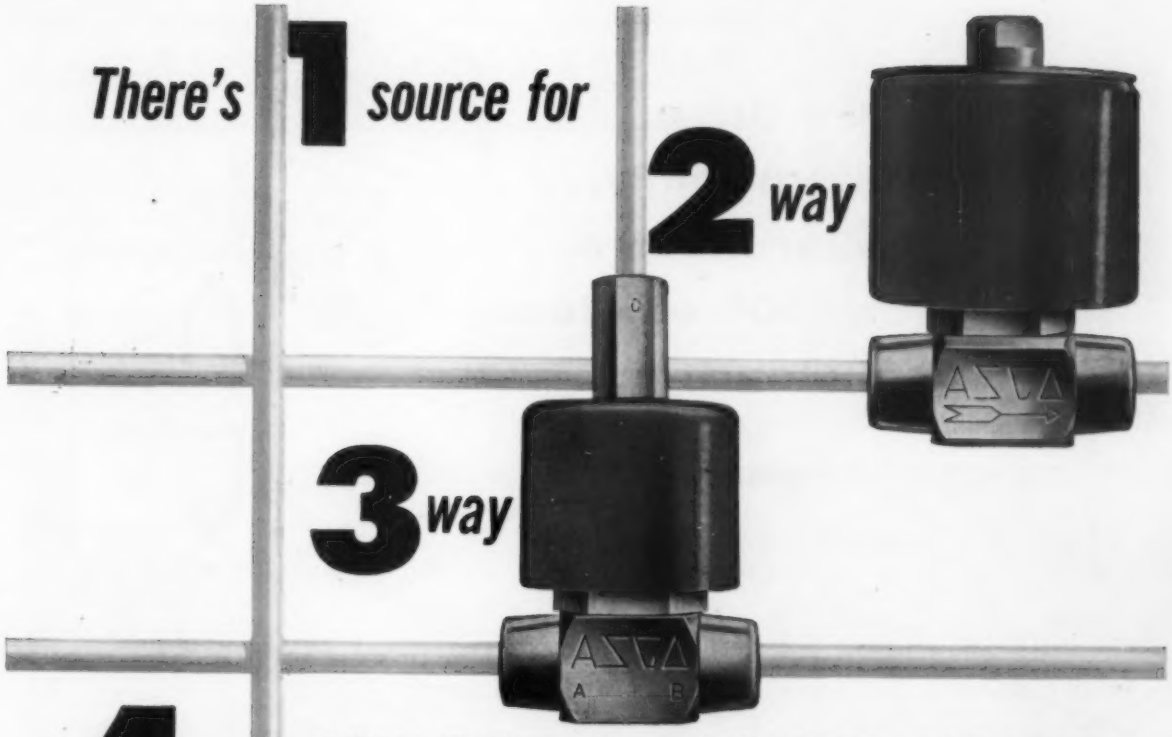
This adding and subtracting machine counts up to 100,000.00 in decimal amounts, adds and subtracts feet, inches and fractions of an inch, including sixteenths. It is not necessary to convert the dimensions into decimals and reconvert the result; you add or subtract the dimensions as they come. The result is also direct, expressed in feet, inches and fractions. The subtraction mechanism is on reverse side. The manipulation of the machine is exactly the same for subtraction as it is for addition.

The machine slides in a metal holder hinged to the case.

For office use stands with cover are available. The machine also comes fitted into saddle leather case with note-book (5 x 7 x ¾ in.), which weighs 1 lb. Alexdraft Equipment Co., 159 N. Daisy Ave., Pasadena, Calif.

For more information—
Circle 123, inside back cover

There's 1 source for 2 way 3 way or 4 way MIDGET SOLENOID VALVES

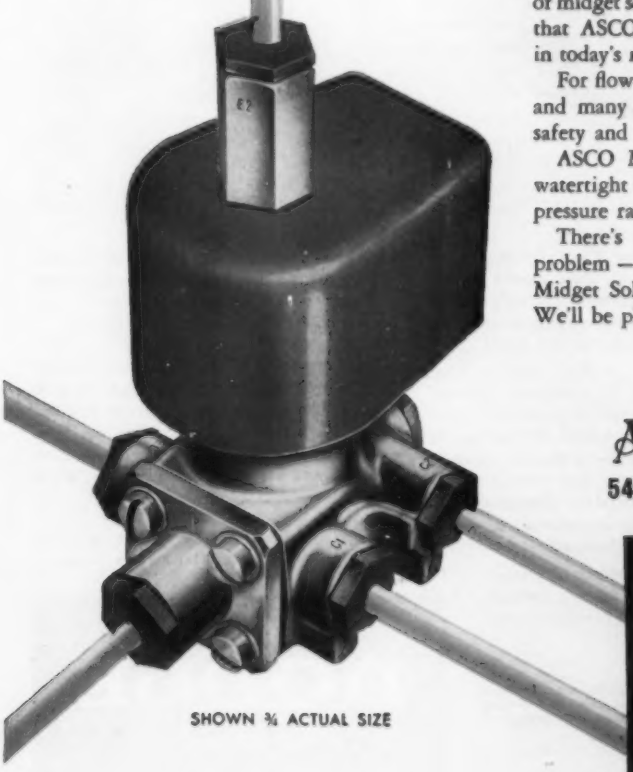


Progressive designers, the men who lead the trend toward miniaturization, depend on ASCO as the one source for a full line of midget solenoid valves. The unexcelled quality and dependability that ASCO pioneered in the solenoid valve field is found, too, in today's midget solenoid valves. Only the size has been reduced.

For flow applications using air, gas, water, light oil, refrigerants and many other liquids, ASCO Midget Valves assure complete safety and truly exceptional performance.

ASCO Midget Solenoid Valves are available with standard, watertight or explosion-proof enclosures. Pipe sizes ⅛" and ¼"; pressure range 0-1000 psi.

There's *one* source that solves virtually any solenoid valve problem — ASCO. Write today for complete data on ASCO Midget Solenoid Valves — or outline any of your requirements. We'll be pleased to assist you.



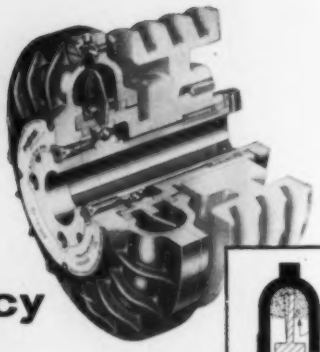
SHOWN ¾ ACTUAL SIZE

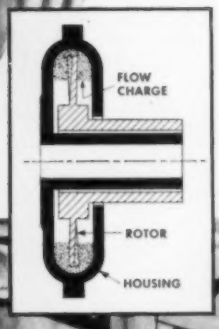
AUTOMATIC TRANSFER SWITCHES
SOLENOID VALVES ELECTROMAGNETIC CONTROL

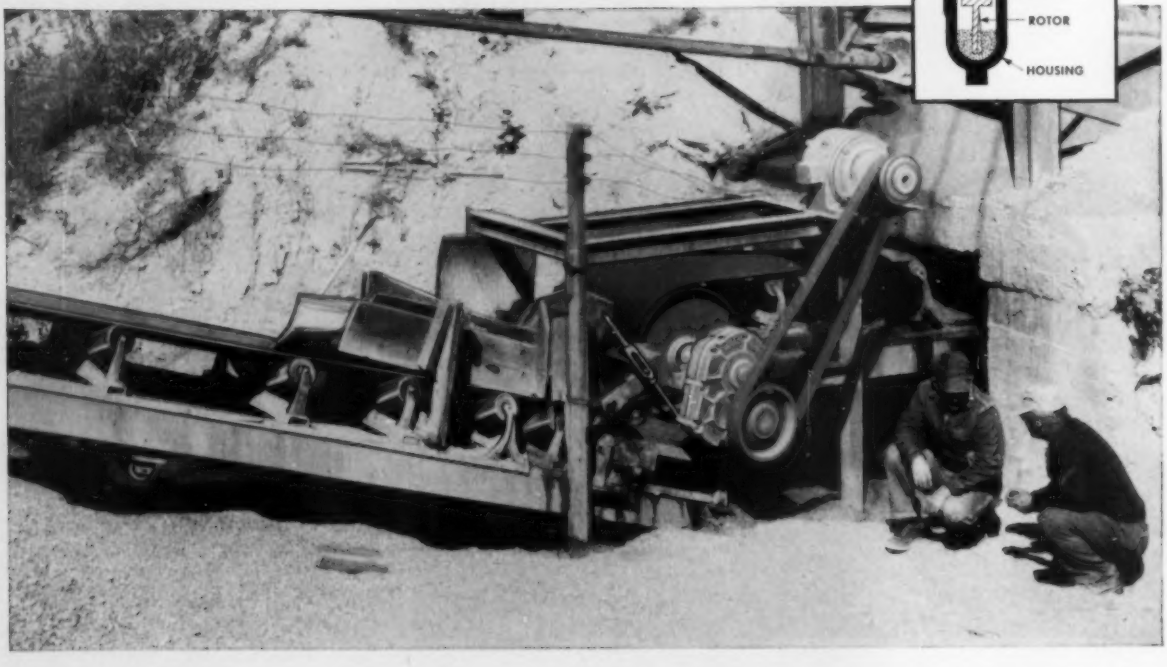
Automatic Switch Co.
54G Hanover Road, Florham Park, New Jersey
FRontier 7-4600

ASCO®

This new drive starts loads smoothly... with smaller motors ...and gives 100% efficiency at full load!







FLEXIDYNE

THE DRY FLUID DRIVE

This tunnel conveyor, 225 feet long, handles 500 tons of sand and gravel per hour—8 to 16 hours a day.

With Flexidyne, the motor picks up the load easily and smoothly. Power investment is reduced, power costs cut, maintenance simplified and conveyor belts are protected against breakage.

Flexidyne, the Dry Fluid Drive, is the new development that starts loads smoothly, that protects against shocks and overloads, that saves power and that gives 100% efficiency at full load!

The "dry fluid" in Flexidyne is heat treated steel shot. A measured amount, called the flow charge, is contained in the housing, which is keyed to the motor shaft. When the motor is started, centrifugal force throws the flow charge to the perimeter of the housing, wedging it between the housing and the rotor which transmits power to the load.

After a momentary slip between housing and rotor, the two become locked together and achieve full load speed without slip and at 100% efficiency during the running cycle. Changes in weather—hot or cold—inside or out—do not affect operation of Flexidyne.

Flexidyne is now available in 8 sizes—for use with electric motors and internal combustion engines from 1 hp to 300 hp. While each size is power rated, the flow charge can be varied at will to give tailor-made torque for your particular job. Write for Bulletin A-640.

DODGE MANUFACTURING CORPORATION
1200 Union Street, Mishawaka, Indiana

CALL THE TRANSMISSIONEER, your local Dodge Distributor. Factory trained by Dodge, he can give you valuable help on new, cost-saving methods. Look for his name under "Power Transmission Machinery" in in your classified phone book, or write us.

DODGE
of Mishawaka, Ind.

CATALOGS and BULLETINS

To obtain copies of literature described below, circle corresponding number on postcard inside back cover. For those catalogs and bulletins available only when requested on company letterhead, see page 364.

Oil Seals–Catalog 305, 60 pp. Contains complete data on seals available as well as recommendations on design adaptability in relation to pressure, temperature, and shaft speed conditions. Under shaft sizes, the various designs available are grouped, with a cross-section of each design on the same or adjoining page. One section deals with essential parts of oil seals, with all parts named according to the SAE standard radial seal nomenclature. Another section gives a concise description of the synthetic rubber elastomers used in sealing elements. A chart indicates their general service characteristics on typical fluids. Proper installation of seals is treated in still another section. Victor Mfg. & Gasket Co., P. O. Box 1333, Chicago 90, Ill.

Circle 124, inside back cover

Permanent Magnets, Thermistors, Varistors–Booklet DMPM-56-2, 12 pp. Discusses use of magnets in miniaturization, characteristics and properties of magnets, application of thermistors and varistors to product design. General Electric Co., Detroit 32, Mich.

Circle 125, inside back cover

Tool Steels–Catalog, 52 pp. Contains data and tables on steels. Other sections discuss common tool steel failures, comparison and index of trade names, recommended grades for various conditions. Burke Steel Co., Inc., 30 Sherer St., Rochester 8, N. Y.

Circle 126, inside back cover

Oiltight Pushbuttons–Catalog 5606A, 31 pp. Contains data on pushbuttons rated to 550 a-c-d-c selector switches, pilot lights and accessories. Schematic wiring diagrams for the various types of switches are included. Furnas Electric Co., 1000 McKee St., Batavia, Ill.

Circle 127, inside back cover

Adapters for Tube Fittings–Catalog 4360, 12 pp. Contains data on straight thread plugs and adapters, O-rings for straight thread fittings, and steel and brass pipe fittings. Parker Appliance Co., 17325 Euclid Ave., Cleveland 12, Ohio.

Circle 128, inside back cover

Variable Pitch Drives–Catalog V183-A, 12 pp. Contains data and diagrams on units designed for use with standard "B" and "C" section belts and driven sheaves. Browning Mfg. Co., Maysville, Ky.

Circle 129, inside back cover

Socket Head Cap Screws–Brochure, 4 pp. Contains diagrams and data on units from 1⅛ to 3 in. dia. Cleveland Cap Screw Co., Box 545, 2917 E. 79 St., Cleveland, Ohio.

Circle 130, inside back cover

Self-locking Clinch Nut–Brochure, 8 pp. Contains specification data and describes advantages of reduced size and weight of new nut. The Kaynar Co., Box 2001, Terminal Annex, Los Angeles 54, Calif.

Circle 131, inside back cover

Shear Pin Sprockets–Folder 2747, 4 pp. Contains data on sizes, torque ratings, hub dimensions and keyseats. Link-Belt Co., Prudential Plaza, Chicago 1, Ill.

Circle 132, inside back cover

Asbestos Products for Reinforced Plastics–Bulletin T-56, 18 pp. Contains data and tables on fibers, cloths and properties. Raybestos-Manhattan, Inc., Manheim, Pa.

Circle 133, inside back cover

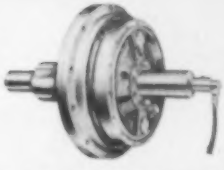
High-Temperature Electronic Wire–Folder 19-586, 4 pp. Contains data on wire for electronic equipment, meters and panels, with three types of insulation: thermoplastic, nylon and silicone. General Electric Co., Bridgeport 2, Conn.

Circle 134, inside back cover

Silicone Rubber Gum Stock–Data sheet, 28 pp. Contains data and tables

(Continued on page 352)

DODGE PRODUCTS you should know



AIR-GRIP CLUTCHES

CHAIN COUPLINGS

SEALED-LIFE V-BELTS

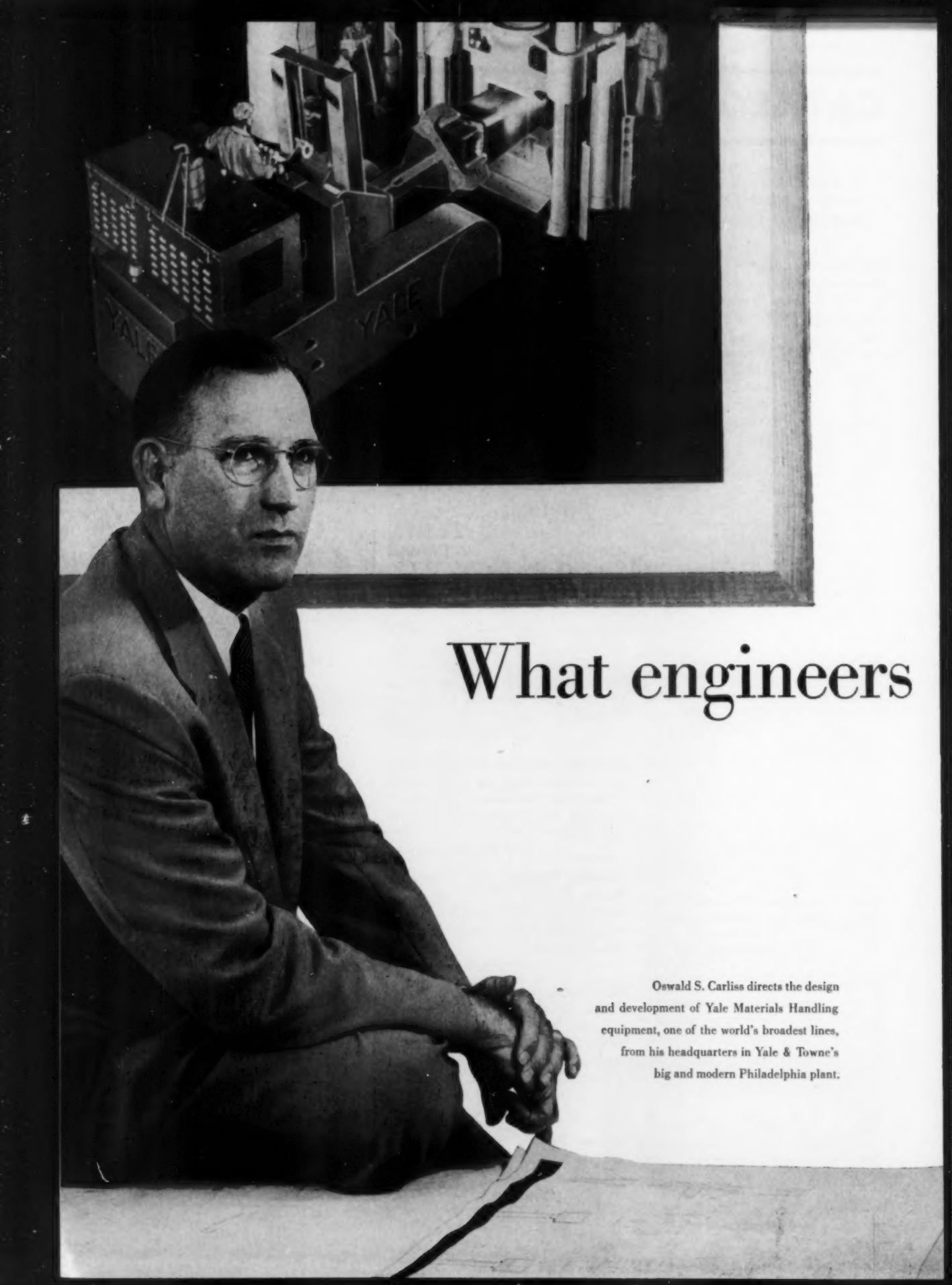
DODGE BULLETINS YOU SHOULD HAVE

- Air-Grip Clutches. Technical data, sizes and selection tables. Bulletin A634
- Chain Couplings, Taper-Lock Sprockets and Dodge Roller Chains. Technical data and selection methods. Bulletin A644
- Sealed-Life V-Belts. Construction details and complete data on sizes, pitch lengths and outside lengths. Bulletin A606

Write for your copies.

DODGE MANUFACTURING CORPORATION
1200 Union Street • Mishawaka, Indiana

DODGE
of Mishawaka, Ind.



What engineers

Oswald S. Carliss directs the design and development of Yale Materials Handling equipment, one of the world's broadest lines, from his headquarters in Yale & Towne's big and modern Philadelphia plant.

"We have constant need for catalogs in locating new sources of materials and component parts. But even with a full-time librarian, developing and maintaining a really useful catalog file is a disappointing task. The catalogs distributed in Sweet's Product Design File are a far better and more convenient source for the kind of information we need. As a result, we depend heavily on Sweet's, and look there first for information.

"It would be tremendously helpful to us if all manufacturers would put their catalogs in Sweet's, where the indexing makes them so easy to find, and where we are sure we are getting up-to-date and reliable product information."

Oswald S. Carliss *Director of Engineering,*
Yale Materials Handling Division Headquarters
Yale & Towne Manufacturing Company,
Philadelphia, Pennsylvania

need from suppliers...

Thank You, Mr. Carliss. You have expressed what thousands of design engineers feel about the PRODUCT DESIGN FILE, namely: *It is the one best answer to faster and more efficient materials and component selection.* And the 1957 PRODUCT DESIGN FILE is the biggest and most useful one ever distributed.

Every time you refer to your PRODUCT DESIGN FILE you will be struck by the logic of a system which files, classifies and indexes the catalogs you need *before* they are distributed to you. In this way, service-conscious manufacturers make certain that their market-planned catalogs are *always* conveniently on hand the instant you want them.

We are already hard at work on the 1958 PRODUCT DESIGN FILE. It will bring you a still bigger and more diverse collection of permanently bound, completely indexed, design-specialized catalogs.

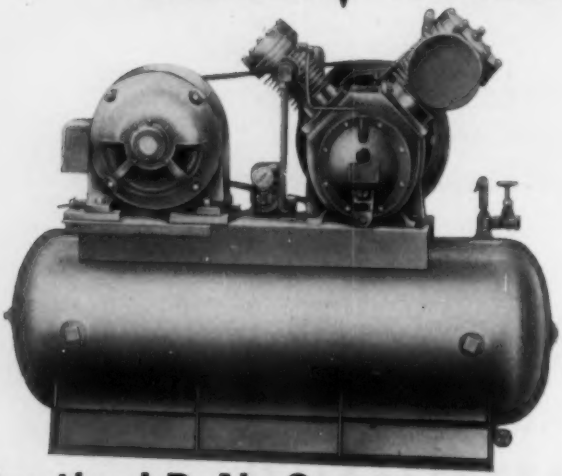
We welcome your comments at any time about the value of the PRODUCT DESIGN FILE to you. Tell us the products for which you are particularly anxious to have catalogs included. Write: Sweet's Research Manager at the address below.

SWEET'S CATALOG SERVICE
Division—F. W. Dodge Corporation
119 West 40th Street, New York 18.

Designers, producers and distributors of manufacturers' market-specialized catalogs for the industrial and construction markets.

A good point to consider...

BALANCED V CONSTRUCTION



Why the I-R Air Compressor is right for your product!

WHETHER YOU ARE DESIGNING equipment for your own operation or for resale, there are many points about Ingersoll-Rand's *Balanced V Construction* which will help maintain the quality of your air-powered product. These 3 advantages are typical:

1. **Dependable performance.** The I-R compressor is built to operate reliably, quietly, years longer.

2. **Efficient design.** It delivers more air-per-horse-power, size for size, than other compressors.

3. **Looks like Quality** . . . and it is! Compact, well-constructed, durably built, it carries the name and has the quality plant operators expect.

Get more detailed information on I-R Air Compressors—½ to 20 H.P.—to determine the advantages they bring to your own products. For prompt response, write to:

Ingersoll-Rand

3-352 11 Broadway, New York 4, N. Y.

for gaskets, O-rings and molded parts. Union Carbide and Carbon Corp., 30 E. 42 St., New York 17, N. Y.
Circle 135, inside back cover

Switches–Catalog 200, 4 pp. Contains data on pushbutton, lever and turn switches. Donald P. Mossman, Inc., Brewster, N. Y.
Circle 136, inside back cover

Terminal Blocks–Brochure, 4 pp. Contains data on quick connect units. Rohden Mfg. Co. Inc., 4739 Montrose Ave., Chicago 41, Ill.
Circle 137, inside back cover

Fasteners–Brochure, 20 pp. Contains data, diagrams and charts on sheet metal nuts. Fastex, 195 Algonquin Rd., Des Plaines, Ill.
Circle 138, inside back cover

Basic Switches–Catalog 78, 32 pp. Contains data on phenolic-encased, metal-covered, hermetically sealed high-temperature units for airborne equipment. Micro Switch, Freeport, Ill.
Circle 139, inside back cover

Nickel-Cadmium Storage Batteries–Bulletin 501, 8 pp. Contains data on operation with curves of discharge and charge characteristics for electronic, aircraft and communications equipment. Nickel Cadmium Battery Corp., 66 Pleasant St., Easthampton, Mass.
Circle 140, inside back cover

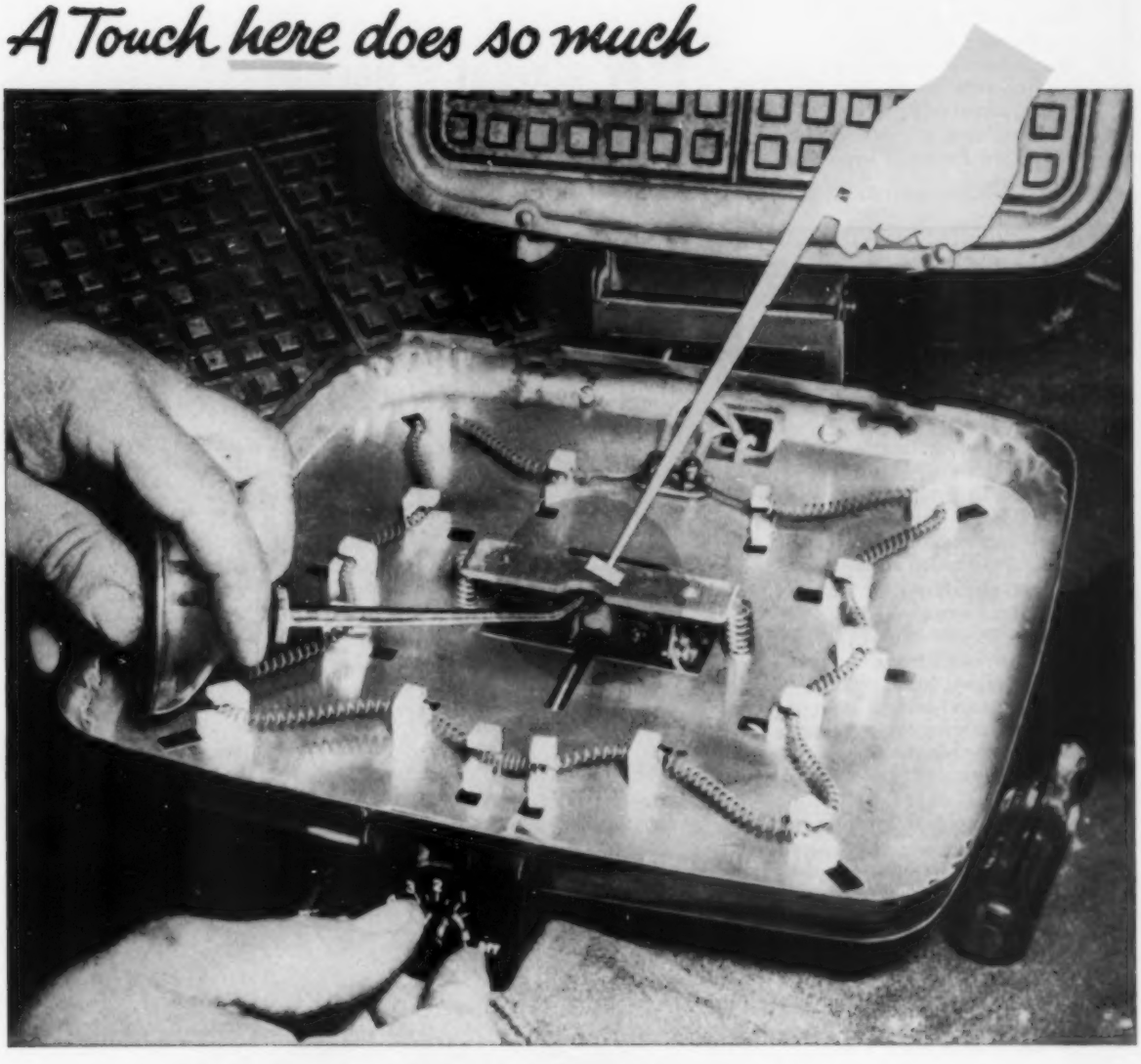
Industrial Ceramics–Catalog 57, 20 pp. Contains data on mechanical, physical and electrical properties of several materials. Star Porcelain Co., 34 Muirhead Ave., Trenton 9, N. J.
Circle 141, inside back cover

Teflon-Lined Pipe–Bulletin T-100, 2 pp. Contains data on lined steel pipe. Haveg Industries, Inc., 900 Greenbank Rd., Wilmington 8, Del.
Circle 142, inside back cover

Miniature Socket Screws–Brochure, 4 pp. Contains data on socket head cap and set screws in sizes No. 0 to 3, either in alloy or stainless steel. Standard Pressed Steel Co., Box 545, Jenkintown, Pa.
Circle 143, inside back cover

D-c Magnet Brake–Bulletin GEA-6214, 8 pp. Contains data, diagrams
(Continued on page 356)

A Touch here does so much



RED HOT CELL MATE . . . FOR LIFE

A touch of 'dag'™ Colloidal Graphite gives lifetime lubrication to parts operating next to red-hot elements in pop-up toasters and other appliances. It does the same for planetary gears exposed to 1500° F. in high-intensity searchlights.

Where life performance must be built into inaccessible mechanisms, 'dag' dispersions form thin, protective films capable of withstanding temperature extremes and other severe conditions. Your Acheson Service Engineer can discuss the application of 'dag' dispersions related to the life performance of your design. Talk with him soon, and write for Bulletin 423 containing information on design applications for 'dag' dispersions. Address Dept. PE-3.

dag®

ACHESON COLLOIDS COMPANY

Port Huron, Michigan...also Acheson Colloids, Ltd., London, England

ACHESON COLLOIDAL DISPERSIONS:

Graphite · Molybdenum Disulfide · Zinc Oxide · Mica and other solids

Offices in: Boston · Chicago · Cleveland · Dayton · Detroit · Los Angeles Milwaukee · Philadelphia · New York · Pittsburgh · Rochester · St. Louis · Toronto

Made by Hadley Products Co., Inc., Marietta, O., the Electronaire filter is used in heating and air conditioning units. Features unique, permanently electrostatic thermo-plastic monofilaments. Grilles are Penmetal expanded aluminum.

They market a permanent filter with the help of expanded aluminum

Sales appeal of an Electronaire filter is permanence . . . and washability. Never needs replacing; cleans easily in water.

The retaining grilles won't rust . . . can't ever loosen . . . yet allow free passage of air and water. That's because they are shaped from remarkably versatile Penmetal expanded aluminum.

When aluminum is slit and stretched to form expanded metal, it retains its inherent advantages —gains the added features of even lighter weight, high percentage of open area and greater strength. This combination of properties offers a tremendous potential for product design and improvement. Particularly where grilles or guards are required.

So, take advantage of Penmetal expanded aluminum in your designs and in your selling. But first, you ought to have a reference copy of bulletin 507 E-M. Write today.

PENN METAL COMPANY, INC.

General Sales Office:
40 Central Street, Boston 9, Mass.

Plant: Parkersburg, W. Va.

District Sales Offices: Boston, New York, Philadelphia, Pittsburgh, Chicago, Detroit, St. Louis, Dallas, Little Rock, Seattle, San Francisco, Los Angeles, Parkersburg

METAL MARK Penmetal 1869 OF QUALITY

A FEW OF THE MANY OTHER USES OF EXPANDED METAL:

Air Conditioning Unit Grille (Berns Manufacturing Co., Chicago, Ill.)

Railroad Car Air Filter (Farr Company, Los Angeles, Calif.)

Fan Enclosure (Atlas Tool & Manufacturing Company, St. Louis, Mo.)

PM-118

DON'T LET THE MISSING LINK handicap your automation developments

Co-axial conductor breakout

Cable with umbilical connectors.

Multi-breakout harness assembly.

Molded 90° backshell.

Rack and panel connectors with molded 90° cable attachment.

Self governing devices are only as reliable as the circuits which control them. Pacific Automation Products offers an integrated product and service program whereby at the "bread board" stage, designers can specify their needs for cable to complete the electronic circuitry involved in modern day automatic equipment.

Pacific Automation Products supplies a liaison engineering team to function with your engineering staff, resolving your design problems before they become problems.

ENGINEERED CABLE Pacific Automation Products engineering specialists conceive the ultimate in circuit combinations within a cable.

PRELIMINARY DESIGN Combination of many complex circuits into one cable construction, including breakouts to accommodate design configuration, can be specified in first development unit fully documented for subsequent reordering.

UNIFORMITY ASSURED Built to fit the exact configuration of the design, wires are helically laid providing maximum flexibility, compactness and durability.

QUALITY COMPONENTS Combining the superior qualities of plastic insulated wire with the known versatile properties of neoprene, Pacific Automation Products' cable is available to meet all environmental conditions.

Whatever quantity you require – in long lengths or short – Pacific Automation Products can supply engineered cable and assemblies, uniform and certified as to performance with a known dependability factor, and in time to meet your schedules.

Write for Bulletin 163.

Engineers and technicians are invited to investigate career opportunities with us. Submit resume for an interview.

Pacific Automation Products, Inc.
1000 AIR WAY, GLENDALE 1, CALIFORNIA
CHapman 5-6871 · TWX: GLN 7371
137 Walnut Hill Village, Dallas, Texas
FLeetwood 2-5806

On the increase...
quality equipment powered by quality-built

KOHLER ENGINES
Modern short stroke · 4-cycle · Air-cooled

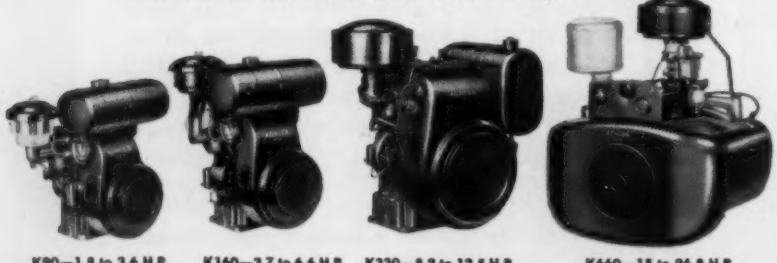
Superior design and performance have led to a steady increase in the use of Kohler Engines in every field of power equipment.

Precision-built to Kohler quality standards, Kohler Engines insure full-rated power in a wide range of sizes, with maximum response to heavy loads, remarkable low speed performance, snappy all-weather starting. Large bore and modern short stroke cut engine friction, increase piston ring life, give utmost usable power. Fully anchored magneto has easily accessible outside breaker points. All models have liberal oil capacity—pressure lubrication on the two larger sizes, K330 and K660. The K660 has tapered roller bearings at both ends of the crankshaft, smaller models have ball bearings at both ends. Sturdy, compact design provides low weight per H.P. output. Special silencer muffler and large capacity oil bath air cleaner lessen noise. Smooth, balanced operation reduces equipment vibration, cuts wear, prolongs life.

Kohler branch offices are located in 16 principal cities. Sales and service organizations throughout the country have parts available and will assist you in selecting a Kohler Engine best suited to your needs. Write for information.

Part of the growing list of Manufacturers using Kohler Engines:

Gorman Rupp Co., Mansfield, Ohio • *Diaphram Pump*
Kwik Mix, Port Washington, Wis. • *Concrete Buggy*
Crescent Pump Co., Rockland, Mass. • *Diaphram Pump*
Wald Industries, Inc., Huntingdon, Pa. • *Highway Line Marker*
E. R. Brenholts, Gerard, Pennsylvania • *Road Grader*
Atwater Strong Company, Atwater, Ohio • *Air Sweeper*
Meade Products Mfg. Co., Meade, Kansas • *Riding Lawn Mower*
Hansen Equipment Co., Beloit, Wis. • *Chemical Farm Sprayer*
Minn-Kota Manufacturing Co., Moorhead, Minn. • *Grain Swather*
O. W. Kromer Company, Minneapolis, Minn. • *High Clearance Sprayer*
Franklyn Products, Milwaukee, Wis. • *Portable Mink Feeder*
Phillips Conveyor Company, Memphis, Mo. • *Coal Conveyor*



K90—1.8 to 3.6 H.P. K160—3.7 to 6.6 H.P. K330—8.2 to 12.5 H.P. K660—15 to 26.8 H.P. (2 cylinder opposed)

Kohler Co., Kohler, Wisconsin • Established 1873

KOHLER OF KOHLER

PLUMBING FIXTURES • HEATING EQUIPMENT • ELECTRIC PLANTS
AIR-COOLED ENGINES • PRECISION CONTROLS

and tables that show how unit meets AISE standards in 8, 10, 13, 16, 19, and 23-in. wheel sizes. General Electric Co., Schencetady 5, N. Y.
Circle 144, inside back cover

Steel Tubing and Fittings–Bulletin V-157, 6 pp. Contains diagrams and data on units for vacuum systems and conveying lines. H-P Products, Inc., Louisville, Ohio.
Circle 145, inside back cover

Plate-Type Rheostats–Bulletin GEA-6474, 8 pp. Contains information, charts and typical applications. General Electric Co., Schenectady 5, N. Y.
Circle 146, inside back cover

Steel Casting Specifications–Bulletin, 6 pp. Summarizes all specifications recommended for commercial, railroad, federal and military use. Steel Founders' Society of America, 606 Terminal Tower, Ceveland 13, Ohio.
Circle 147, inside back cover

Autotransformer–Bulletin, 24 pp. Contains data and diagrams on adjustable units. General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.
Circle 148, inside back cover

Strain Gages–Bulletin, 15 pp. Contains data and prices of SR-4 devices, self-compensated gages, high temperature and room temperature foil gages. Dept. SO 104, Baldwin-Lima-Hamilton Corp., Waltham, Mass.
Circle 149, inside back cover

Stainless Steel Fasteners–Catalog, 12 pp. Describes government specification for aircraft bolts, slotted and Phillips machine screws, flat and round rivets, and washers. Allmetal Screw Products Co., Inc., 821 Stewart Ave., Garden City, L. I., N. Y.
Circle 150, inside back cover

Miniature, Hermetically Sealed Switches–Catalog 5, 8 pp. Contains data on subminiature, standard single blade, double blade, and special switches designed for custom applications. Also included is data on standard and special actuators. Haydon Switch, Inc., Waterbury, Conn.
Circle 151, inside back cover

Hydraulic Hose Fittings–Catalog 4433, 4 pp. Contains data on units ranging from ⅜ through 2 in. ID.
(Continued on page 358)

No. 1
of a series of ads dealing with basic facts about thermostatic metals.

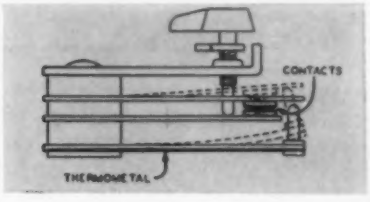
Designing for Product Improvement With WILCO THERMOMETAL®

Thermometal (thermostatic metals) are laminations of two or more different metals with unequal coefficients of expansion. The difference in rate of expansion causes them to change shape with changes in temperature and, if restrained, to build up force.

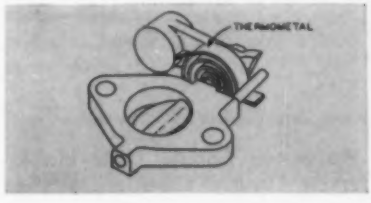
This basic fact is of great industrial importance, for it makes possible the application of Thermometal in indicating and controls devices in 4 broad categories.

1. Temperature Indication, as in Thermometal thermometers.

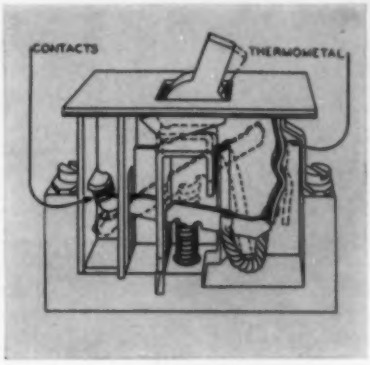
2. Temperature Control, as in electric irons, toasters, or room thermostats.



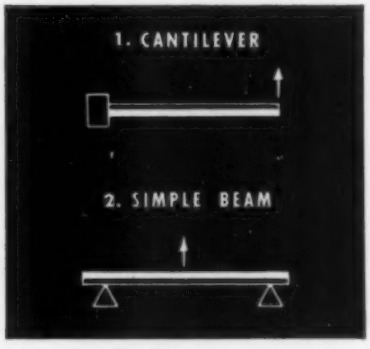
3. Temperature Compensation, as in automotive heat manifold control.

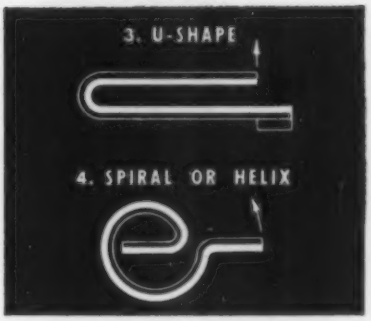


4. Sequence Control by Functional Heating, as in electric circuit breakers for overload protection.



Thermometal can be rolled to any desired thickness and formed into almost any shape, and still respond to temperature changes. For this reason it is a unique thermal element, which functions without linkages, seals, special mountings, and in most applications without electrical energy. Thermometal can be made to perform simple flexing motion, rapid snap action, and rotary or twisting motions. Four basic shapes are used alone or in combinations to obtain these motions:





According to the application, the selection of Thermometal is generally governed by four performance factors:

1. Maximum temperature encountered in service: (300°F, 500°F, 800°F, or 1000°F)
2. Temperature range over which maximum sensitivity is required: 50°–300°F (low); 150°–450°F (medium); 300°–600°F (high); 500°–800°F (extra high)
3. Deflection and force required
4. Electrical conductivity

The H. A. Wilson Company is the American pioneer in the development and manufacture of thermostatic metals. We produce over 40 metals for this use. Also we make a complete line of electrical contacts for use with Thermometal.

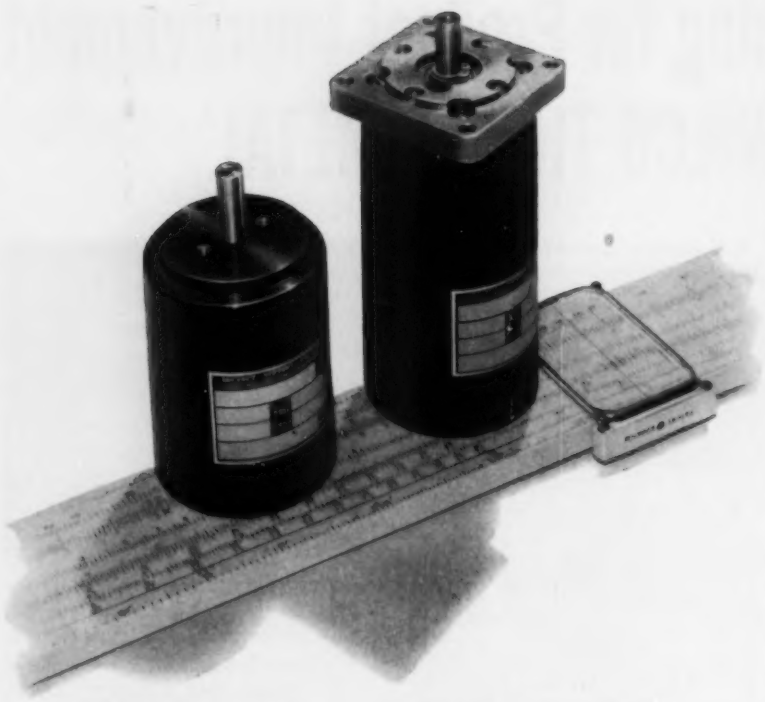
Reprints of this series are available on request. For further information about our products, ask for the Wilco Blue Book, the most complete reference manual ever written on Thermometal. And if you have an immediate application problem for Thermometal or other Wilco products, please tell us. Our engineering service is at your disposal.

WILCO®

THERMOMETAL
ELECTRICAL CONTACTS
COMPOSITE METALS
SPECIAL PURPOSE ALLOYS

THE H. A. WILSON COMPANY
2655 U. S. Route 22, Union, New Jersey
Branch Offices: Chicago • Detroit • Los Angeles • Providence

ENGELHARD INDUSTRIES



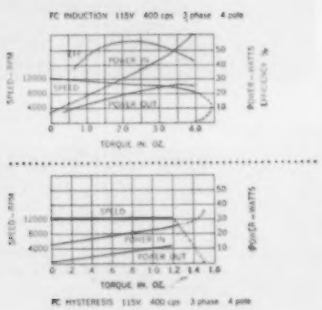
NEW A. C. MOTOR LINE GIVES YOU 10^5 STANDARD VARIATIONS

From Globe you can get fast delivery of complete miniature power systems designed around new FC motors—115 or 200 V.A.C., 60 or 400 cycles—induction, hysteresis, or dual speed rotors, wound 3 phase, 2 pole or 4 pole; 2 phase, 2 pole or 6 pole; single phase with a matched capacitor. Units are designed to meet MIL specs; operating characteristics and configuration can be modified.

Package can include integral gearing, either planetary or spur. Choose from 102 standard ratios from 4:1 to 3,000,000:1. Choose from 408 standard speeds. Gear units range in length from 1.043" to 1.953". WRITE FOR FC BULLETINS.

Globe's small AC motor packages are built around units 1.07" dia., 1.25" dia., and the newest 1.675" dia. x 2.250" long. Standard modifications in type, winding, gearing, and performance offer you millions of combinations at reasonable cost. Globe also makes D.C. governed and gear reduced motors, servo motors, actuators, timers, generators, gyros, blowers, fans, and control systems.

GLOBE INDUSTRIES, INC.
Dayton 4, Ohio


FC INDUCTION 115V 400 cps 3 phase 4 pole
SPEED - rpm
POWER - watts
EFFICIENCY - %
TORQUE IN. OZ.
FC HYSTERESIS 115V 400 cps 3 phase 4 pole

Parker Appliance Co., 17325 Euclid Ave., Cleveland 12, Ohio.
Circle 152, inside back cover

Electrical Contacts—Catalog C522, 4 pp. Describes materials, properties, forms and uses of units. Gibson Electric Co., 8358 Frankstown Ave., Pittsburgh 21, Pa.
Circle 153, inside back cover

Pneumatic Transmission System—Bulletin 750, 8 pp. Describes a form of pneumatic transmission which has been developed to provide a sensitive and accurate type of instrumentation. Simplex Valve & Meter Co., Lancaster, Pa.
Circle 154, inside back cover

Glass—Booklet, 64 pp. Explains manufacturing methods, applications, and history of glass. Corning Glass Works, Corning, N. Y.
Circle 155, inside back cover

Steel Tube Fittings—Catalog, 48 pp. Contains charts and data on hydraulic flareless units. Weatherhead Co., 128 W. Washington Blvd., Fort Wayne, Ind.
Circle 156, inside back cover

Stainless Castings—Booklet, 28 pp. Contains data on applications and properties. Allegheny Ludlum Steel Corp., Pittsburgh 22, Pa.
Circle 157, inside back cover

Temperature Control—Bulletin 106, 2 pp. Contains data on unit for either liquids or gases and for temperatures up to 1000 F. Burling Instrument Co., 16 River Rd., Chatham, N. J.
Circle 158, inside back cover

Fluid Power Equipment—Bulletin 400, 8 pp. Contains data on hydraulic pumps, control valves, and cylinders. New York Air Brake Co., Kalamazoo, Mich.
Circle 159, inside back cover

Pushbutton Control Units—Booklet, 26 pp. Contains diagrams, charts and data on oiltight pushbuttons, indicating lights, selector switches and enclosures. Cutler-Hammer Inc, 315 N. 12 St., Milwaukee 1, Wis.
Circle 160, inside back cover

Multi-Row Cylindrical Roll-Neck Bearings—Catalog 436, 24 pp. Con-

(Continued on page 360)

Farm implement dealers cooperated with the Watonwan County, Minn., Safety Council, to stress the dangers of unguarded power take-off shafts in this county fair exhibit. "Empty chairs" mean "empty tractor seats" too!

Photo courtesy of Watonwan County Safety Council

BLOOD BROTHERS *Integral*

Safety-Shielded Drive Lines help farm implement dealers keep their customers safe!

For humanitarian reasons—and wise business practice as well—it pays to increase the customer's safety in every possible way. As proof of great progress in the farm implement field, Blood Brothers reports an increase of over 300% in the demand for Integral Safety-Shielded Drive Lines during the past year alone!

Some manufacturers are supplying Integral-Shielded Drives exclusively on *all* power take-off implements they build. This trend to greater safety helps implement builders—dealers—users—everyone!

Saleswise, Blood Brothers Integral-Shielded Drive Lines are helpful too. They offer a strong "plus" selling feature that *proves* you place the farmer's best interests *foremost.* Designed to avoid careless or absent-minded removal, they'll be *in place* to protect implement operators at all times.

If you *build* implements, write for information on the sizes you need.

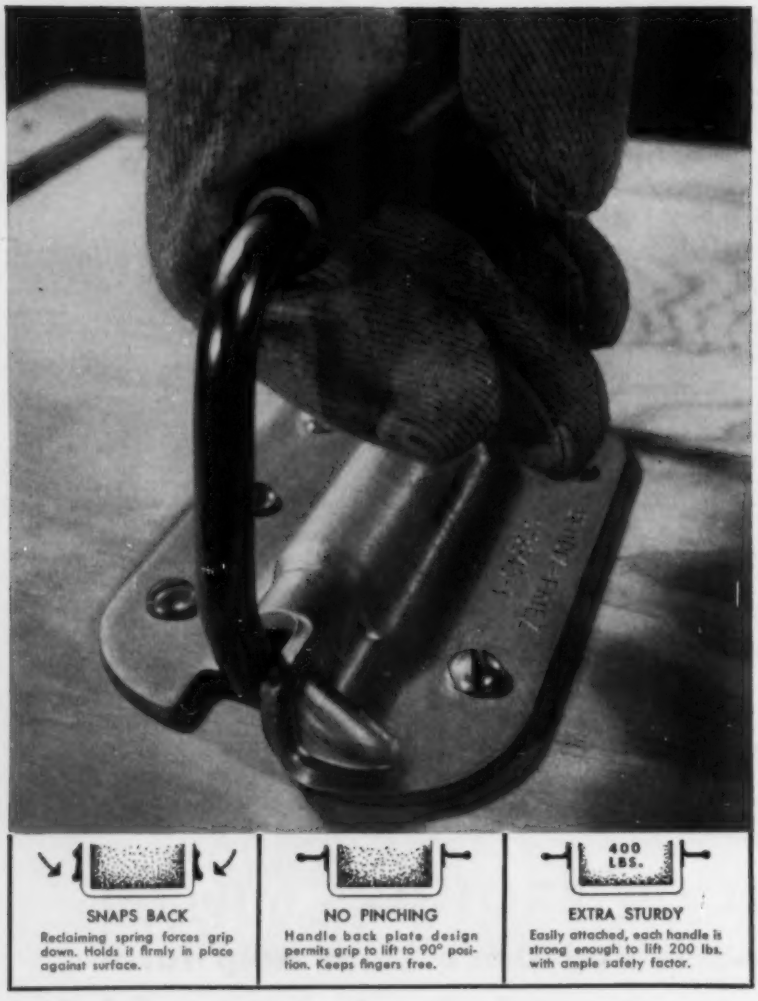
FOR FARM IMPLEMENTS, MORE BLOOD BROTHERS UNIVERSAL JOINTS ARE USED THAN ALL OTHER MAKES COMBINED

BLOOD BROTHERS MACHINE DIVISION

ROCKWELL SPRING AND AXLE COMPANY

ALLEGAN, MICHIGAN

UNIVERSAL JOINTS AND DRIVE LINE ASSEMBLIES


SNAPS BACK
Reclaiming spring forces grip down. Holds it firmly in place against surface.
NO PINCHING
Handle back plate design permits grip to lift to 90° position. Keeps fingers free.
400 LBS.
EXTRA STURDY
Easily attached, each handle is strong enough to lift 200 lbs. with ample safety factor.

BEST HANDLE YET FOR INDUSTRIAL CONTAINERS, CARRYING CASES OR ELECTRONIC EQUIPMENT!

Meets Military Specifications C-4150A and T-945A

There's nothing fragile about this handle! It's strong, rugged, rattle proof, rust and corrosion resistant. Made of tough stainless steel and heavy-gauge anodized aluminum, it will lift 200 lbs. with a big safety factor in reserve.

This Bendix handle has proven its superiority on military and industrial carrying cases, shipping containers and on electronic equipment. The special grip sleeve will not crack, chip, become sticky or tacky in temperatures from −65° to +160°F. Our patented design eliminates pinching, holds grip firmly against surface when not in use. Attaches easily with nuts and bolts, welding, etc.

Write today for complete specifications and quantity discounts. Bendix-Friez, 1404 Taylor Ave., Baltimore 4, Maryland.

Friez Instrument Division

Bendix
AVIATION CORPORATION

tains data on units designed for heavy-duty service in roll-neck mountings on hot and cold rolling mills. SKF Industries, Inc., Front St and Erie Ave., Philadelphia 32, Pa.

Circle 161, inside back cover

Machine Tool Limit Switch–Bulletin 956, 8 pp. Contains data describing 21 heavy duty contact arrangements. R. B. Denison Mfg. Co., 102 St. Clair Ave., N.W., Cleveland 13, Ohio.

Circle 162, inside back cover

Symbols for Fluid Power Diagrams–As sponsor for ASA Sectional Committee Y32 on graphical symbols and designations, ASME announces distribution of this proposed standard for criticism and comment. ASME, 29 W. 39 St., New York 18, N. Y.

Circle 163, inside back cover

Stainless Steel Honeycomb Structures–Bibliography, 3 pp. Gives references published since 1950 on fabrication, welding, brazing, testing and designing honeycomb. American Silver Co., 36-07 Prince St., Flushing 54, N. Y.

Circle 164, inside back cover

Printed Circuitry–Pamphlet, 4 pp. Contains data on printed circuit design. Croname Inc., 3701 Ravenswood, Chicago 13, Ill.

Circle 165, inside back cover

Template-Ruler-Cross Sections–0.070, 0.103, 0.139, 0.210 and 0.275 in. are cut out of styrene plastic and sent to engineers whose companies are now using or intend to utilize a four-lipped ring in various sealing applications. Minnesota Rubber & Gasket Co., Minneapolis, Minn.

Circle 166, inside back cover

Steel Castings–Folder, 20 pp. Contains description of 12 metals for casting. Dodge Steel Co., 6501 Tacony St., Philadelphia 35, Pa.

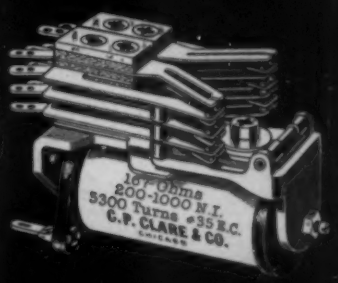
Circle 167, inside back cover

Rectifier Power Supply Equipment–Catalog, 16 pp. Contains data on low voltage units. Opad Electric Co., 69 Murray St., New York 7, N. Y.

Circle 168, inside back cover

Welded Steel Tubing–Booklet, 16 pp. Contains data on tubing formed from zinc-coated aluminum-coated,

(Continued on page 364)



Do you have an unsolved "X" spot in your design?
...A place where you would put the "ideal" relay–if you had it?

TYPE J DESIGNS TO MEET WIDE DESIGN REQUIREMENTS

Standard Type J Relays

Twin contacts (Palladium standard). Rated current-carrying capacity: 4 amperes, 150 watts.

Power Type J Relays

Heavy-duty contacts riveted to springs. Code 18 (Silver). Rated current-carrying capacity; 10 amperes, 27½ volts d-c.

Type J Video Relays

For switching video and other high-frequency currents.

CLARE Type J Relays have been filling difficult "X" spots in industrial designs for more than a decade.

Processed of the most positive of all twin-contact designs, the CLARE Type J Relay has all the desirable features of a telephone type relay—yet greatly reduced in bulk.

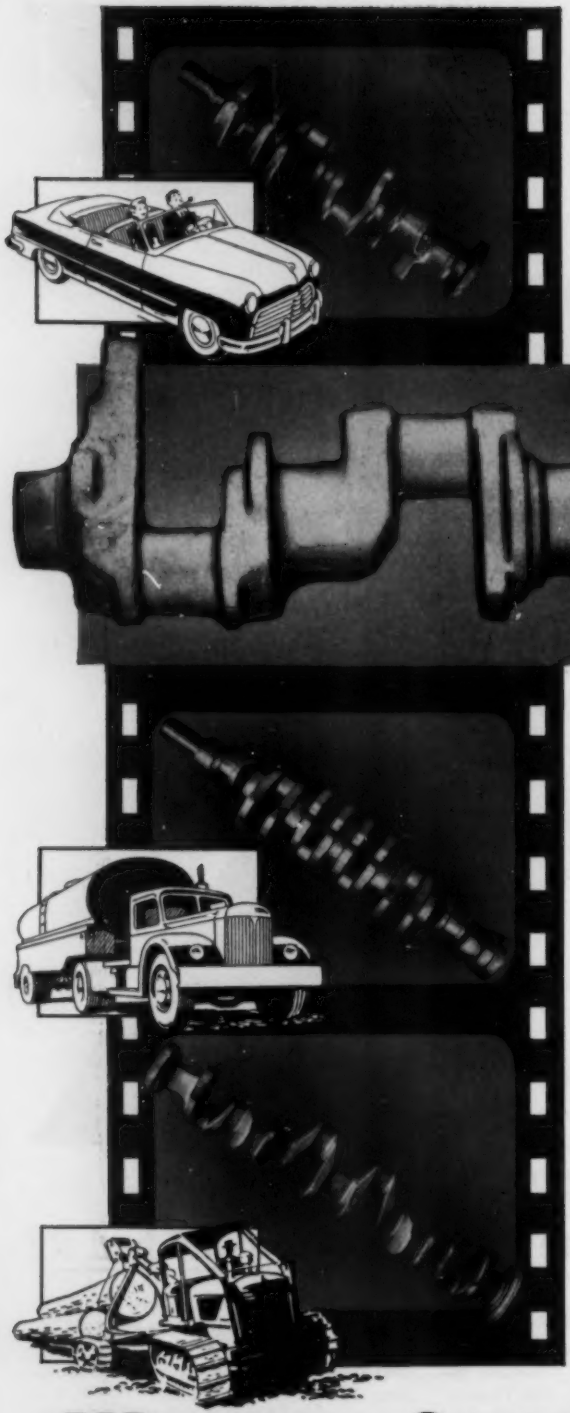
Many basic design ideas have been improved by this relay—a CLARE original—whose wide acclaim has provoked a lot of imitators but never an equal—whose many distinctive features have provided an eminently satisfactory solution to many perplexing problems involving efficient, long-life relay operation.

Let us work with you to pick the best relay for YOUR important relay requirement. Address: C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Illinois. In Canada: C. P. Clare & Co., 659 Bayview Avenue, Toronto 17. Cable address: CLARELAY.

Write for Engineering Data Book and Bulletin 119

CLARE RELAYS

FIRST in the industrial field



There's no substitute for the FORGED crankshaft

Crankshafts have been made successfully by other methods of fabrication and have proven to be *good enough* for certain non-critical applications—but for maximum dependability of the modern, compact, high compression, high torque engine a forged crankshaft is essential.

The forging process assures, to the greatest degree possible, uniformity and predictability of physical properties with a minimum variance from piece to piece or from one location to another in the same piece.

Wyman-Gordon has been forging crankshafts since the beginning of the internal combustion engine era and today produces more crankshafts for a greater variety of applications than any other company in the world. In a crankshaft there is no substitute for a forging, and in a forging there is no substitute for Wyman-Gordon quality and experience.

WYMAN-GORDON COMPANY

Established 1883

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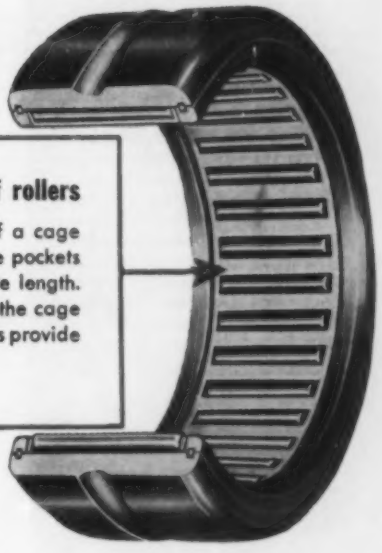
FORGINGS OF ALUMINUM • MAGNESIUM • STEEL • TITANIUM

ORANGE *Cage Type* NEEDLE BEARINGS

reduce friction to a minimum



HERE'S THE REASON:

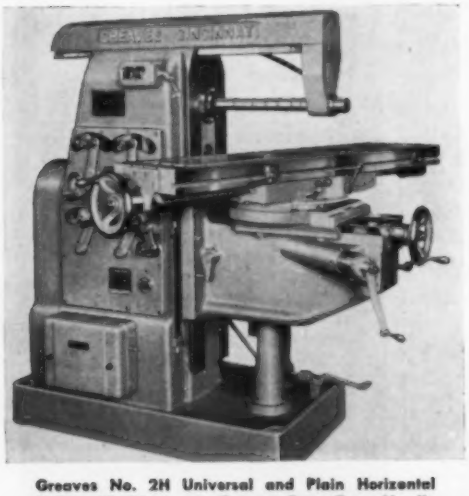
Cage assures permanent alignment of rollers

Each needle roller is retained in pockets of a cage made of anti-friction, non-ferrous metal. These pockets guide and align the rollers along their entire length. The cage does not wear on the rollers, since the cage land rides on the outer race. Square end rollers provide maximum effective roller length.

Run quieter...smoother...cooler...longer

because

The Rollers Roll evenly — never Skew or Slide



Greaves No. 2H Universal and Plain Horizontal Milling Machines use Orange Cage Type Needle Bearings in the Rapid Traverse, eliminating friction which caused overheating of former bearings. Greaves Machine Tool Div. of J. A. Fay & Egan Co. has used these bearings for 7 years with excellent results.

Many advantages for your equipment

The aligned-roller action of Orange Cage Type Needle Bearings gives you a true anti-friction, non-skewing needle bearing of high load capacity and small space requirements, with the following bonus values for your installations:

- **True-running in any position . . . horizontal—tilted—vertical—or overhung mountings.**
- **Less affected by misaligned mountings or uneven loading.**
- **Successful on relatively high speed applications.**

Orange Cage Type Needle Bearings are fully interchangeable with conventional needle bearings, in a complete range of stock sizes from ½" to 8" shaft diameter. Stocks and engineering service in all industrial areas.

Write for Engineering Manual M-56, giving construction, capacities, dimensions, etc.

ORANGE ROLLER BEARINGS

ORANGE ROLLER BEARING CO., Inc.
551 Main Street, Orange, N. J.

Needle Bearings — Staggered Roller Bearings
Journal Roller Bearings — Thrust Roller Bearings
Cam Followers

beaver ball screws

Successor to the Acme screw drive and preferred in many applications to hydraulic and pneumatic systems. Guaranteed 90% efficiency in converting rotary twist to linear push (or vice versa). Employs a stream of precision balls and ground lead to eliminate drag and wear in delicate instruments to massive wind tunnel jacks. Any diameter or travel: indexing, inching, traversing. Literature, consulting engineering service available.

Fastest growing source for ball screws

Beaver Precision Products INC.
CLAWSON, MICH.

hot-rolled steel, and cold-rolled steel. Armco Steel Corp., Middletown, Ohio.

Circle 169, inside back cover

Caps and Filler Necks–Brochure, 16 pp. Contains diagrams and data on units for fluid tank installations. Eaton Mfg. Co., 17877 St. Clair Ave., Cleveland 10, Ohio.

Circle 170, inside back cover

Flareless Tube Fittings–Catalog 4320, 28 pp. Contains data on fittings for mounting in SAE straight thread boss utilizing O-ring for sealing. Parker Appliance Co., 17325 Euclid Ave., Cleveland 12, Ohio.

Circle 171, inside back cover

Resin for Polyurethane Foam–Bulletin, 6 pp. Contains data on foam which can be produced in various densities and consistencies by mixing with resin and correct catalyst. Chase Chemical Corp., 3527 Smallman St., Pittsburgh 1, Pa.

Circle 172, inside back cover

Letterhead Requests Only

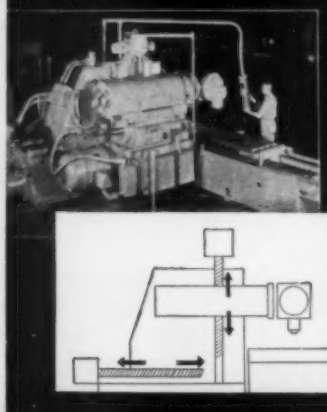
Manufacturers who publish following literature ask that requests for copies be made on company letterheads.

Production of Titanium Shaped Castings–TML Report No. 60, 48 pp. Contains information on furnaces, materials, alloys and casting design. Titanium Metallurgical Laboratory, Battelle Memorial Inst., Columbus 1, Ohio

Computer for Variable Speed Drives–Unit, given free, can be used for solution of any formula involving two variables, raised to any power or root, and a constant. Reverse side of rule contains commonly used formulas. Graham Transmissions, Inc., Menomonee Falls, Wis.

Electrical Components–Handbook, 70 pp. Contains specifications and diagrams on starters, contactors, relays, control units, switches, timing devices, solenoids, circuit breakers, transformers, and magnetic brakes. Cutler-Hammer, Inc., P. O. Box 463-4, Milwaukee 1, Wis.

The same instrument that opens and closes the cowling positions heavy cutter heads



Beaver Ball screws provide rapid, positive, horizontal and vertical positioning of the head of this Sundstrand Milling Machine. To demonstrate the advantage of using Beaver Ball Screws this 14,000 pound head is raised at from ½ to 50 I.P.M. with zero backlash by a 4 H.P. motor and without bulky, expensive counterbalancing.

Can your product be made more efficient with Beaver Ball Screws?

Write for information.

Beaver Precision Products INC.
CLAWSON, MICH.

where DEPENDABILITY counts most –

CONVAIR F-102A INTERCEPTOR

depends upon . . . .

VICKERS®

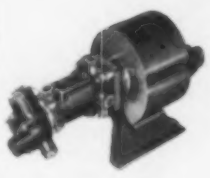
SMALL, LIGHT WEIGHT,
EFFICIENT HYDRAULIC EQUIPMENT

Vickers Flow Sensitive Pressure Regulator permits ram air turbine to generate needed hydraulic flow down to minimum airspeed by regulating the pressure to that which the turbine can produce.

Vickers Thermal Operated Relief Valves protect the primary and secondary hydraulic systems from overheating by automatically depressurizing the circuit at a preset temperature.

Vickers 3000 psi Variable Displacement Piston Type Pumps supply power to the primary and secondary hydraulic systems on the Convair F-102A Interceptor.

Vickers 3000 psi Constant Displacement Piston Type Pump operated by ram air turbine supplies both emergency hydraulic and electric power through the constant speed motor driven alternator in event of engine failure.



Vickers Constant Speed Hydraulic Motor drives the emergency alternator from either the ram air turbine or the secondary hydraulic system.

The Convair F-102A all-weather supersonic stratospheric interceptor depends on Vickers Hydraulics for the following important functions:

- Primary and secondary hydraulic systems
- Ram turbine operated emergency hydraulic system
- Emergency electrical system

The components shown here were selected by Convair for their outstanding dependability and the additional advantages they offer in superior performance. Their technological advancement keeps pace with aircraft development. The pumps are characterized by minimum heat rejection and highest overall efficiency . . . all units shown have small size and light weight. For further information, ask nearest office listed below for Bulletins A-5200-D and A-5209.

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DIVISION OF SPERRY RAND CORPORATION

ADMINISTRATIVE and ENGINEERING CENTER
Department 1454 • Detroit 32, Michigan

EL SEGUNDO DIVISION • Engineering, Sales and Service
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OVERSEAS REPRESENTATIVE: The Sperry Gyroscope Co., Ltd.—Great West Road, Brentford, Middx., England

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ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

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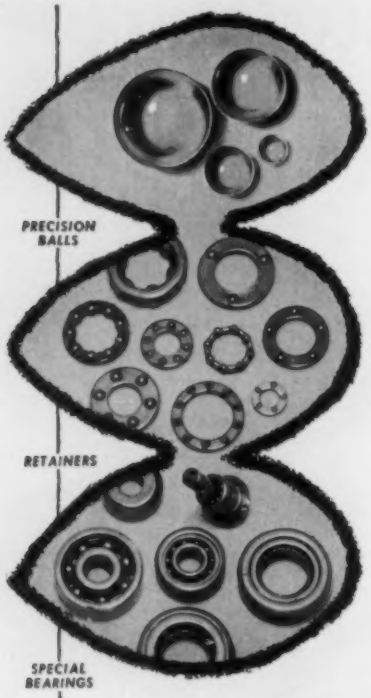
carry the load
ON YOUR BEARING REQUIREMENTS



If your product requires precision balls, thrust retainers, or bearings made to your specifications, it will pay you to check with Hartford. And if you are in a hurry we can ship at once on nearly a thousand items.

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- ☐ *Versa-Twin Double-row Ball Bearings*
- ☐ *Triple Action Tumbling Barrels*
- ☐ *Hartford Steel Burnishing Balls and Materials*

Just attach this coupon to your letterhead and please sign your name and position.

Hartford
PRECISION BALLS ● BEARINGS

HARTFORD STEEL BALL COMPANY, INC.
3 Jefferson Ave., W. Hartford 6, Conn.

Ad Libbing by the Editor

Imitation is often a great temptation. Day after day we read in the newspapers about design piracy, patent litigation and similar things relating to imitation. Imitation is rampant throughout the business world. Wherever possible, the successful enterprise is imitated to the greatest possible extent. Perhaps we all have a tendency to act like the tree dwellers from which we are supposed to be descended, according to Darwin's theory.

Unfortunately, although it is relatively easy to copy, it is not easy to imitate. Copying merely requires the reproduction of a previous creation on exactly the same lines and contours. But to imitate a basic concept or philosophy is entirely different.

Years ago there was a prize-winning slogan used in one of the advertisements of E. R. Squibb & Sons. The slogan is still used by that company. The original advertisement showed an old Arab sitting on his stone bench with a scroll across his knees. Lying down in the sand before him with his chin in the palms of his hands, staring up into the face of the old philosopher and teacher, was a boy. Alongside of this attention-compelling picture was this statement, or a statement very closely resembling it, "Remember my son, the essential ingredient in every product is the honesty and integrity of its maker." The meaning of that thought-provoking statement is obvious. But there is an additional meaning that is along the same lines but in reverse. It is simply this: If there are two products, one the original and the other an imitation thereof, it is indisputably true that the original was created with honesty and integrity whereas the imitation does not possess those essential ingredients.

Unfortunately, only too often when a man makes a study to decide on what he is going to undertake, he looks to the successful men of the past and studies their careers. His logic is that if another person made a success of this product or project, he too could be successful in that line. The assumption is that he considers himself to be at least as smart and probably much smarter than the producer who made a huge success of the undertaking. Ironically, such a procedure has little chance for success.

Many years ago, I visited the Monarch Machine Tool Company and met Mr. Wendell Whipp, who at that time was leading the company into a new period of prosperity. He had taken hold of this company when it was deep in the doldrums, and his first task was to determine the kind of machine tool that this company might manufacture with success and profit. The amazing thing is that Mr. Whipp selected the lowly lathe as the machine tool that he would manufacture in order to convert a dismal industrial operation into a successful one.

I asked Mr. Whipp how it was that he selected the engine lathe as the machine tool that he would concentrate on to bring success to the company. His answer was noteworthy:

"The first thing I did when I was faced with the problem of deciding upon the kind of machine tool that

(Continued on page 368)

Two U. S. Varidrive Syncrogears power this dual mixer designed for processing foam rubber

Question: **"WHY DOES VARIABLE SPEED IMPROVE MIXING?"**

Answer: **"BECAUSE THERE'S ONE RIGHT SPEED FOR EVERY MIXING CONDITION—"** *for example:*

VISCOUS MATERIALS Where dry ingredients are mixed or reacted with vehicles or binders, the materials may go through a plastic state in their reaction; therefore variable speed increases or decreases rpm speed to accommodate the process requirements.

TEMPERATURE VARIATIONS When liquids or semi-solids undergoing mixing lose heat, the speed of the mixer may require reduction progressively or in steps. A Varidrive will give you the precise speeds needed at different levels of temperature.

BATCH BLENDING Different consistencies of batch materials may require slow speed to start, but when they become integrated, higher speed may be applied to reduce time. The same mixer can be used for processing materials of widely varying consistencies by powering it with a Varidrive. Thus you save space and extra equipment.

EXPERIMENTAL PROCESSES You may want to mix new compounds or blends to determine how slow or fast you should make up the batch. Only by variable speed can you get the sensitive rpm needed for experimenting. Varidrive is the answer.

INCREASED VERSATILITY A mixer can be used for many operations with variable speed, whereas a single-speed will restrict its use. A Varidrive gives a mixer its full potential of performance so that you may be able to avoid purchase of extra mixers.

U.S. Electrical MOTORS

U.S. ELECTRICAL MOTORS Inc. · Box 2058, Los Angeles 54, Calif. or Milford, Conn.

Send today for Full Color 16-page Comprehensive Booklet fully describing the

U.S. VARIDRIVE

¼ to 60 hp—2 to 10,000 RPM

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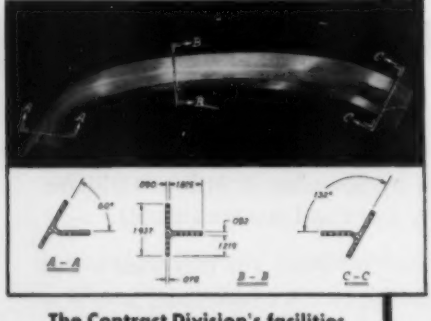
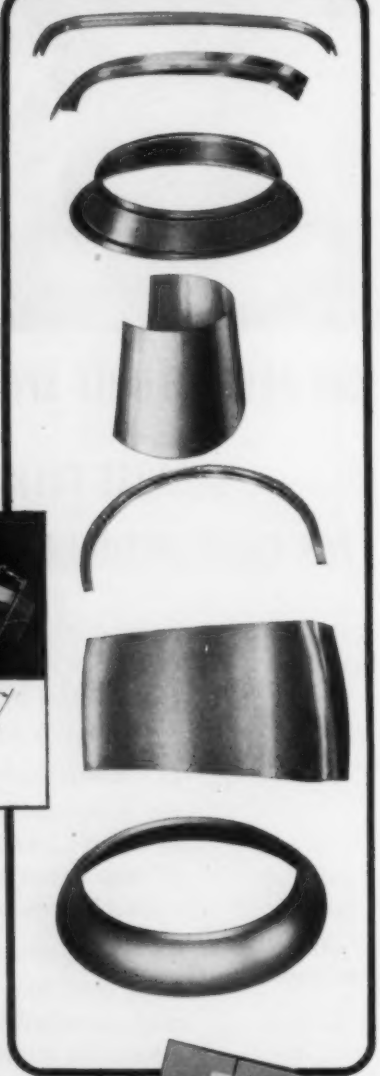
The Contract Forming Division specializes in forming metal to curved shapes. Bath Radial Draw Form methods and stretch form methods are especially suited to producing accurate curved parts from extrusion, strip, sheet and pre-formed sections. A full range of equipment for auxiliary operations is available in the Forming Division.

Bath methods yield accurate parts in the toughest metals... jet engine rings, aircraft and missile shapes, and parts for many other industries.





The Contract Division's facilities are available for production of parts in lots of 100 to 100,000. Send your inquiries to our Estimating Department or write for literature describing in detail the Bath forming methods and the contract facilities available.

THE CYRIL BATH COMPANY

32354 AURORA ROAD • SOLON, OHIO
(LOCATED IN THE GREATER CLEVELAND AREA)
Manufacturers of Radial Draw Formers • Dies • Tools
Press Brakes • Tangent Bending Sequence Presses • Press Type Brakes • Special Machines

we were going to build, was to get catalogs of all the various machine tools, including lathes, shapers, milling machines, planers, turret lathes and all the others. I not only got the current catalogs but also the catalogs of ten, twenty and thirty years earlier. I studied all of these catalogs very carefully in order to be able to visualize the progress that had been made in the design of these various machine tools. It did not take me long to discover that the engine lathe, the kingpin of all the machine tools, was the one machine tool that had progressed least in its design.

"Naturally, if very little improvement had been made in the design of engine lathes, and on the other hand a vast amount of improvement had been made in the design of most other machine tools, it would stand to reason that the engine lathe had been bypassed with reference to design improvements. Therefore the engine lathe offered the greatest opportunities for the development of outstanding, improved designs that would compel attention and capture a gratifying market."

Anybody who is at all acquainted with the history of Monarch will know that is exactly what Wendell Whipp accomplished. Monarch Machine Tool Company has been and still is highly successful, gratifyingly so. Thus Wendell Whipp added his example to prove that the road to success does not lie in imitating others but rather in reaching out and doing that which others had failed to do or had neglected to do.

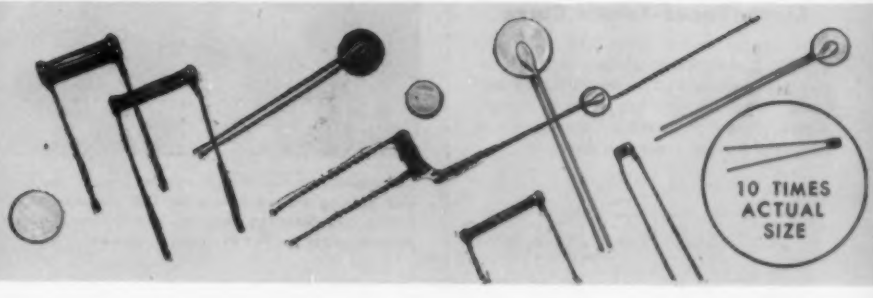
Henry Ford saw the need for a dependable low-price utility automobile. He developed the Model T. It made many fortunes.

Fortunes are made by recognizing a need, then creating the product to fill that need. Into such a creation goes sweat, imagination, energy and "the honesty and integrity of its maker." He whose only contribution to the needs of the world is a counterfeit copy of another's creation, adds nothing to the fund of goods, services and renderings that is not already to be had. The sordid imitation is endowed with neither honesty nor integrity. If the amount of shrewdness and money that went into it had been devoted to creative effort, the results might well have been of great social value. –G. F. N.

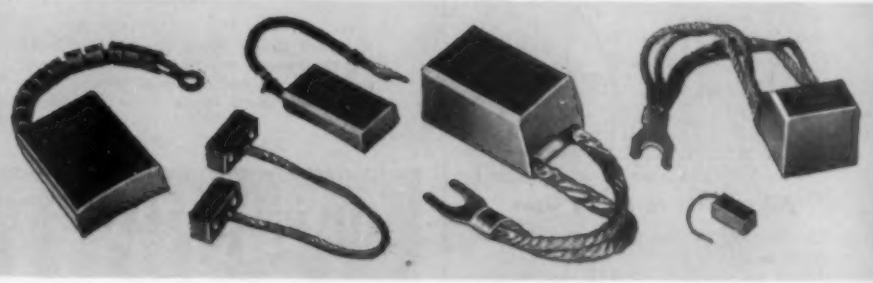
POWDERED METAL PARTS

SELF LUBRICATING BEARINGS

NTC RESISTORS (THERMISTORS)



CARBON AND METAL GRAPHITE BRUSHES



THE Keystone OF OUR BUSINESS is MOLDING and SINTERING!

Four areas of manufacture and sales—*one* basic production technique! We specialize in molding and sintering many different powdered materials—carbon, graphite, metals and metal oxides—for a great variety of end uses. We apply the experience gained in one field to the advantage of all. • Our centralized research and engineering development helps lower costs and improve the performance of each Keystone product. We invite you to benefit by our pioneering—our quarter-century of broad experience—our special manufacturing resources. Let us consult on your needs, and quote on your requirements!

Keystone CARBON COMPANY

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Leadership in Powder Metallurgy Research, Design, Manufacture since 1927

HOWELL MOTOR BRIEFS

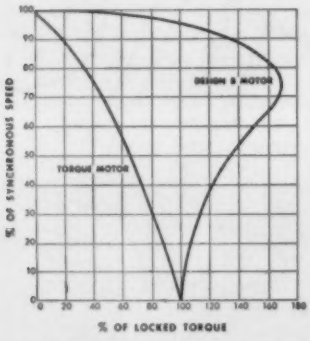
Quick facts for those who apply and specify electric motors

Torque Motors: *They Stall and Hold*

If you want a machine drive to not only apply power but also hold a position or maintain a constant tension, a Howell torque motor may be your solution. Here's a motor that can be stalled, while exerting maximum torque for predetermined intervals, without burning out . . . that can also apply virtually constant torque while operating at a given sub-synchronous speed.

Linear Speed-Torque Curve

The graph below shows this motor's almost linear speed-torque characteristics as compared to a conventional motor's. The secret lies in the design, which produces increased torque while limiting locked rotor current.

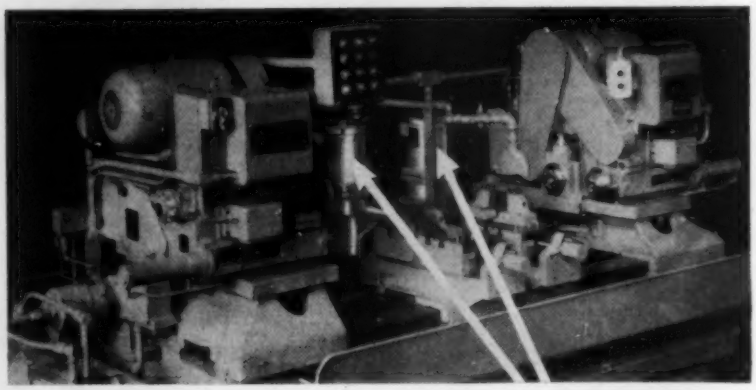


Adaptable to Many Uses

In addition to the clamping, elevator drive and reel tension applications shown at right, Howell torque motors are doing a great many other jobs. Door opening and closing, take-up reeling of film and carbon paper, activating electrical starter contacts and a variety of clutching, chucking and braking operations are among them. They do a quieter, more positive job than many mechanical devices and can often effect important simplifications in machine design.

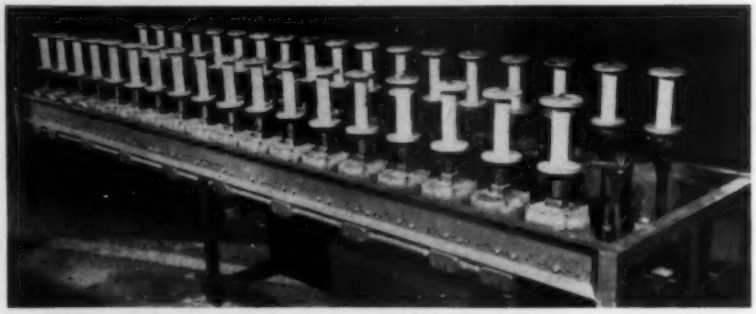
Typical Howell Series 100 Torque Motor

Write us details of *your* requirements. We'll be glad to make suggestions and a quotation.



Two Howell Torque Motors operate clamps for positioning and holding the workpiece on this high-speed, automatic milling and centering machine. Seven Howell motors in all provide power for this precision operation.

A Howell Torque Motor operates the brake and the elevator driving mechanism shown at right. Opening and closing of elevator doors is another typical torque motor application.



A constant, precise tension is maintained on monofilament plastic thread, after extrusion, by the 36 Howell Torque Motors on this winding machine. Multi-speed reeling and winding operations, particularly, are simplified by the use of torque motors in place of geared mechanical devices that are relatively expensive and difficult to keep in adjustment.

HOWELL Red Band MOTORS

HOWELL MOTORS

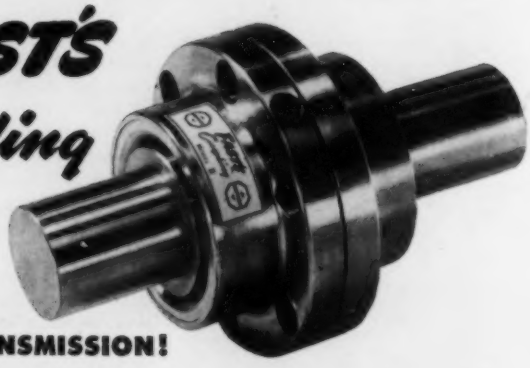
HOWELL ELECTRIC MOTORS COMPANY, HOWELL, MICHIGAN

PRECISION-BUILT MOTORS FOR INDUSTRY SINCE 1915

IN ELECTRICWARE, TOO,
Sharonsteel Quality STANDS OUT
• There are so many advantages to stainless electricware it's no surprise that sales are skyrocketing. Homemakers like the natural beauty of stainless — the way it easily absorbs the punishment of everyday use and stays forever new with a minimum of care.
• Sharon's thorough knowledge of the utensil industry, the ability to produce specification steels of consistent uniformity, plus the finest finishes in the industry are reasons why so many of the nation's leading electricware manufacturers specify Sharon Quality Stainless Steels.
SHARONSTEEL
For 56 Years a Quality Name in Steel
SHARON STEEL CORPORATION, SHARON, PENNA.
CHICAGO, CINCINNATI, CLEVELAND, DAYTON, DETROIT, GRAND RAPIDS, INDIANAPOLIS, LOS ANGELES, MILWAUKEE, NEW YORK, PHILADELPHIA, ROCHESTER, SAN FRANCISCO, SHARON, MONTREAL, TORONTO

The incomparable Model B

FAST'S Coupling



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Designed for light and medium drives—fans, blowers, pumps—a lighter, smaller and lower priced Fast's Coupling! The same famous features found in all Fast's Couplings . . . the same mechanical flexibility, the same positive lubricating principle, the same rugged construction and trouble-free performance . . . the same highly efficient power transmission which has made Fast's Couplings the leader for more than 30 years! Available for shaft sizes up to 2⅝" and sold with Koppers' free engineering service. For the low-cost solution to your shaft coupling problem, write: Koppers Company, Inc., *Fast's Coupling Dept.*, 7103 Scott Street, Baltimore 3, Md.

THE ORIGINAL FAST'S Couplings

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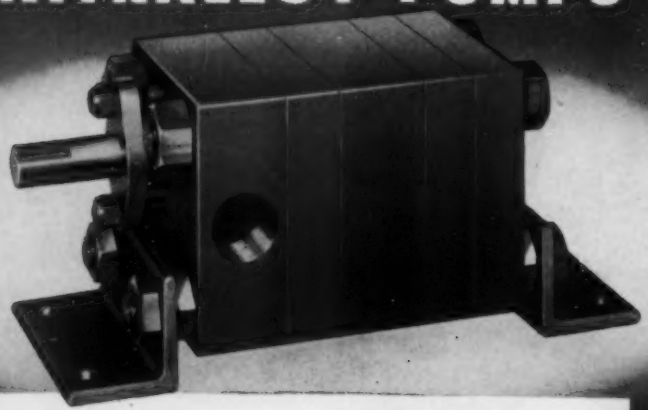
METAL PRODUCTS DIVISION • KOPPERS COMPANY, INC. • BALTIMORE 3, MD. This Koppers Division also supplies industry with American Hammered Industrial Piston and Sealing Rings, Industrial Gas Cleaning Apparatus, Aeromaster Fans, Gas Apparatus. Engineered Products Sold with Service.

NORTHERN NITRALLOY PUMPS



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NORTHERN ORDNANCE, INCORPORATED
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ABSTRACTS

Variably Damped Servomechanisms

Variable damping of servomechanisms, by allowing more efficient use of the inherent capabilities of the servo components, makes possible a considerable improvement in the dynamic performance of the servo. This enables the designer to use lower amplifier gains and smaller servo motors. The stability of the servo can be made less dependent on backlash by using a lower gain error transducer; the variation of the servo characteristics with amplifier gain is quite small. The servo will follow large input velocities accurately, and an ideal transient response is possible with no overshoot and a low settling time.

It is interesting to note that although the system equations are nonlinear, many techniques of operational calculus are applicable.

Abstracted from "Variably Damped Servomechanisms," by L. Schieber, Associate member AIEE, IBM Corp., Endicott, N. Y. presented at AIEE Fall General Meeting, Oct. 1-5, 1956, Chicago, Ill.

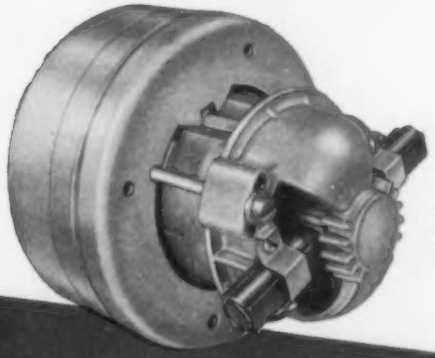
Induction Motor Speed-Torque-Current Curves

Accurate data is presented to show that with a constant rotor temperature the induction motor torque will vary differently from the square of the current. It will be shown that saturation effects may be determined from the locked saturation curve and results applied to that range of speed between zero and one approaching breakdown speed. Knowing these effects the designer is able to provide accurate information for calculation of accelerating time and current which, in turn, makes possible more precise scheduling and coordination of protective relay settings. The procedure is especially valuable in those cases where computers are used in system studies to predetermine these settings.

The average exponential values which express the rate of change of torque with respect to voltage and current may be determined from a

(Continued on page 376)

standard in its field the world over...



Turbine for canister-type vacuum cleaner

Equal Quality Assured For YOUR Motor-Driven Products

The outstanding quality and performance of the Lamb Electric vacuum cleaner motor, shown above, result from proper design and careful manufacture, by personnel having years of experience in the small motor field.

High quality and controlled costs go hand-in-hand because our company is equipped and organized to *custom manufacture* on a volume basis.

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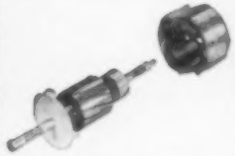
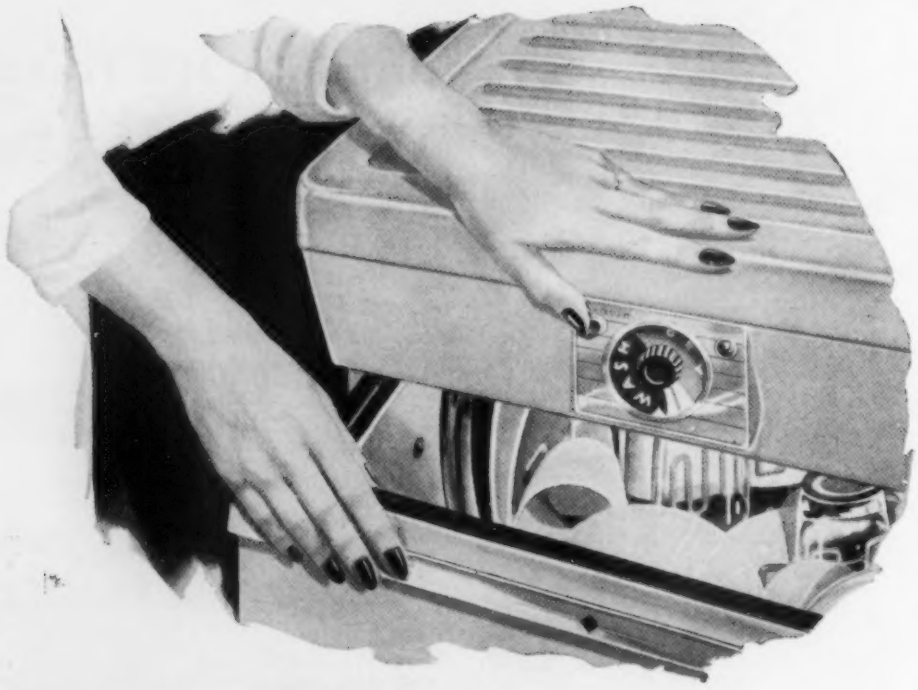


Motor parts for household appliances.

If you are interested in any of the above motors write and we shall be glad to send full information.



Defeating Drudgery– Task for Mallory Timers

Take the burden of tedious, drudging work out of human hands and make operation automatic—and you have a market ready to buy. This concept has proved itself in automatic home laundries, clothes driers, vending machines . . . and offers interesting possibilities in other types of products for factory and farm.

What makes millions of these self-operating devices and appliances *automatic* is a Mallory timer switch! Designed for ruggedness and versatility, Mallory timers are manufactured to high standards of precision at economical cost, for leading appliance makers.

When you are looking for ways to make your new products automatic, you may find that Mallory already has the answer to your timer switch problem. In addition to the Mallory switch that makes a dishwasher automatic, Mallory has other timer switch models—each capable of many variations in cycle time, current rating and other characteristics, cover an almost endless combination of uses. Two of these are illustrated:

For a consultation on your specific automation problem, write or call Mallory today.

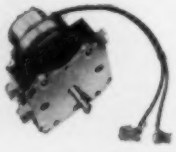
Serving Industry with These Products:

Electromechanical—Resistors • Switches • Television Tuners • Vibrators
Electrochemical—Capacitors • Mercury and Zinc-Carbon Batteries
Metallurgical—Contacts • Special Metals • Welding Materials

For cycles from 1 second to several hours

the new Mallory interval timer controls up to 6 circuits to high precision. Timed portion of the cycle can be adjustable. Motor reset gives positive, spring-less return to original start position. Nominal rating: 10 amperes at 125 volts and 5 amperes at 250 volts; other ratings are possible.

For heavy duty . . .



another Mallory timer controls two 25-ampere circuits. Self-cleaning spring contact assembly has long life, fast opening; ends danger of sticking of contacts. Many variations in motor mounting, built-in bussing and terminal arrangement are available.

Expect more . . . Get more from

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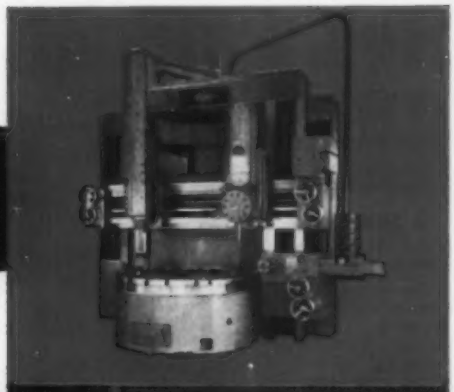
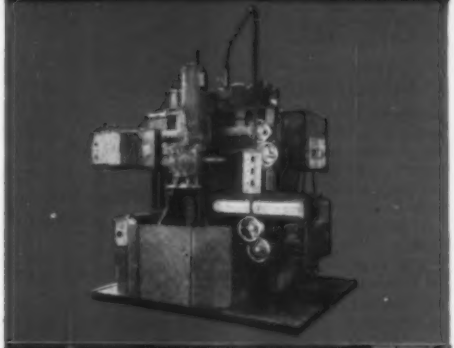


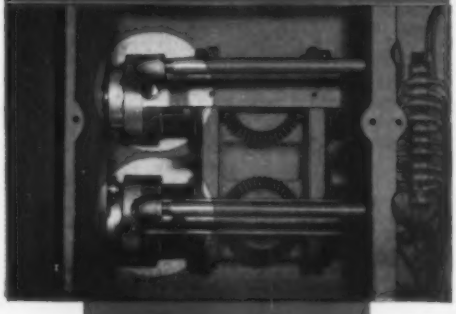
Above: Maxitorq Single and Double Electric Clutches on Bullard Cut-Master Model 75 Machines with single angular turning attachment.

Below: 4 Maxitorq Single Electric Clutches on Bullard Man-Au-Trol Model 75 Machines with double angular turning attachment.

New MAXITORQ ELECTRIC CLUTCHES



Compact, simple in design and construction, fully service-tested, this entirely new clutch design is ideally suited . . . as these Bullard applications show . . . to the new requirements of machine control. Here are the LONG-PROVED advantages of the famous Maxitorq Floating Disc Clutch, now electrically operated, and with these outstanding features . . .



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- NO ADJUSTMENT . . . POSITIVE ENGAGEMENT
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- FLOATING NEUTRAL . . . NO DRAG
- FULL POWER TRANSMISSION
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- UP TO 788 LB. FT. OF TORQUE
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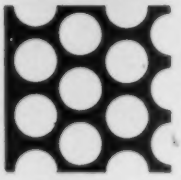

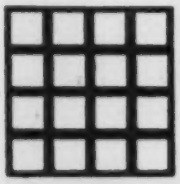

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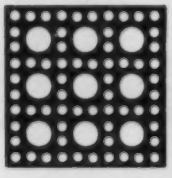

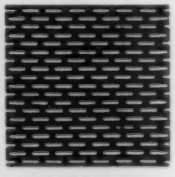

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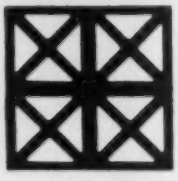

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locked-rotor saturation curve or from a speed-torque-current test. If determined from a locked-rotor test, the amount of testing can be held to a minimum. Rotor temperature can be easily determined and held constant. Such values can be applied from zero speed to a speed slightly lower than breakdown speed. At breakdown, normal exponent values may be used without excessive error; but if accurate values are a necessity they may be obtained either by taking three voltage readings to determine actual exponent values, or by assuming a reasonable estimate based upon the value obtained from locked test. The exponents for each design must be determined separately as saturation and other effects vary from design to design. For system studies, exponents so obtained will enable accurate calculation of voltage dip, acceleration time, and current-time curves for such conditions, hence close and accurate scheduling and coordination of relay settings may be predicted.

Abstracted from "Induction Motor Speed-Torque-Current Curves With a Constant Rotor Temperature" by R. F. Horrell and W. E. Wood, Electric Machinery Manufacturing Co., Minneapolis, Minn., presented at AIEE Winter General Meeting, New York, N. Y., Jan. 21-25 1957.

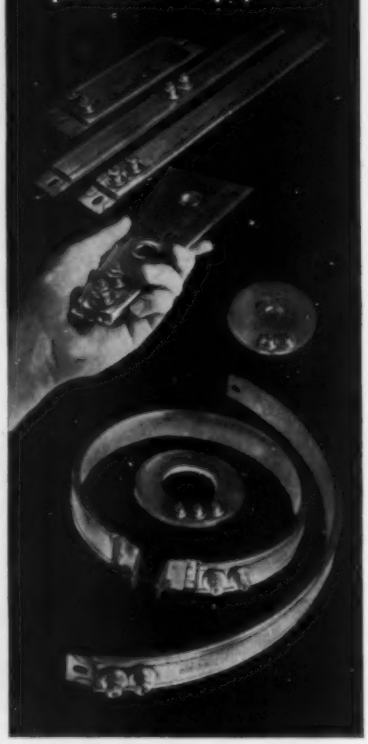
Low Inertia Induction Motors

Several experimental three-phase, 60-cps motors are described, with the best unit having a linear torque-speed characteristic, a maximum rating of 0.175 hp, a starting time of 0.015 sec, and a reversal time of 0.026 sec. These times compare to 0.039 and 0.053 sec respectively for an experimental low-inertia three-phase, 60-cps motor of conventional construction but designed for fast response, and to 0.21 and 0.38 sec respectively for a commercial ¼-hp, three-phase, 60-cps motor.

This performance is achieved by substituting for the conventional design of a squirrel cage rotor a new two-part rotor consisting of an outer low-inertia hollow-rotor constructed in the form of a thin magnesium sleeve that surrounds the iron core needed to complete the magnetic circuit efficiently. In effect this arrangement serves to separate the major torque-

(Continued on page 380)

Clean, uniform, exact heat to match the size and shape of your production equipment



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Lengths 4" to 96" Widths ¾" to 2½"
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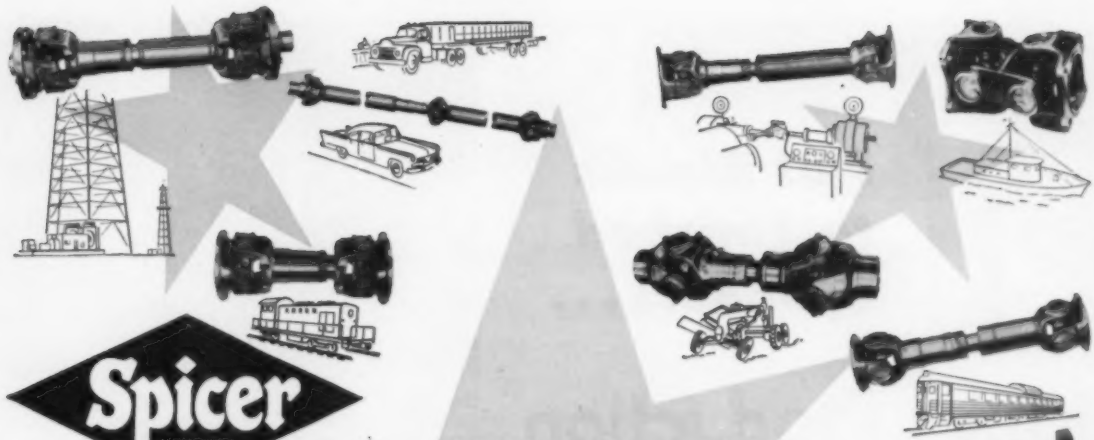

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Wherever you see movement . . . on land or water, in the sky or underground . . . chances are you will find one or more Spicer Universal Joint and Propeller Shaft units delivering power efficiently and dependably.

Spicer produces hundreds of different drive lines in thousands of variations, for use in the automotive, aviation, transportation, marine, agricultural and industrial fields.

The first successful, commercially-produced universal joint for automotive use was introduced by Clarence W. Spicer in 1904. In 1957, backed by over 50 years of continuous service and development, Spicer Drive Lines are being used in a majority of the automotive vehicles made throughout the world.

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Sliding splines have ground finish on ALL contact surfaces, high hardness, and iron manganese phosphate coating.

True bearing alignment with rigid one-piece yoke design. *This rigidity is the essence of accuracy.*

Precision bearings with improved surface hardness and finish.

Dynamically balanced to exacting limits.

Uniform high quality propeller shaft tubing. Special steels used to Dana specifications.

Wide selection of flange and yoke types, and a complete range of sizes to suit each individual requirement.

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SPICER PRODUCTS: Transmissions, Universal Joints, Propeller Shafts, Torque Converters, Axles, Gear Boxes, Power Take-Offs, Power Take-Off Joints, Rail Car Drives, Railway Generator Drives, Stampings, Spicer and Auburn Clutches, Parish Frames, Spicer Frames, Forgings. Universal Joints also Manufactured in Canada by Hayes Steel Products Limited, Merritton, Ontario.

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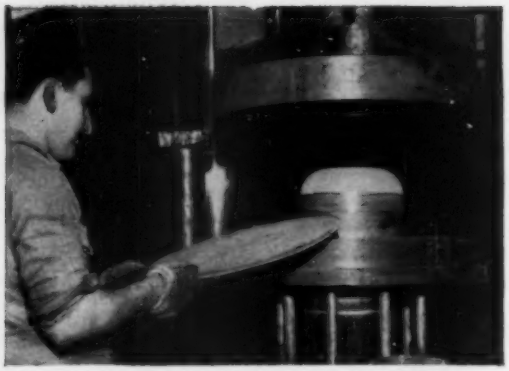
The Bonderite and Bonderlube combination provides effective lubrication and acts as a non-metallic parting layer between work and dies. More severe deformations are possible, reducing the number of press operations and process anneals necessary. Die life is lengthened and surface finish improved.

Bonderite and Bonderlube, by more efficient lubrication, help plants reach new production levels, get more efficient and economical production, and achieve better, more uniform quality.

Parker's cold forming experience in many plants and on many products is available to apply on your cold forming problems at once. Write or call today.



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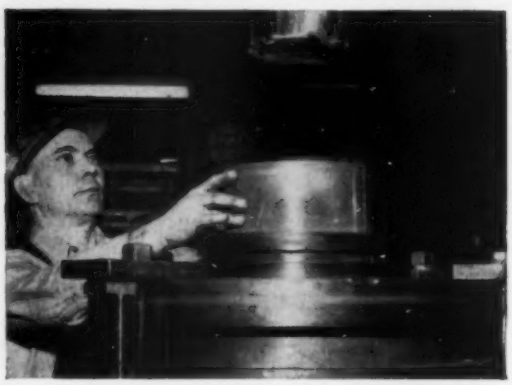

Second reduction: Final diameter of part with respect to length determines number of reductions required. Photos courtesy NORRIS-THERMADOR Corporation, Los Angeles, California.

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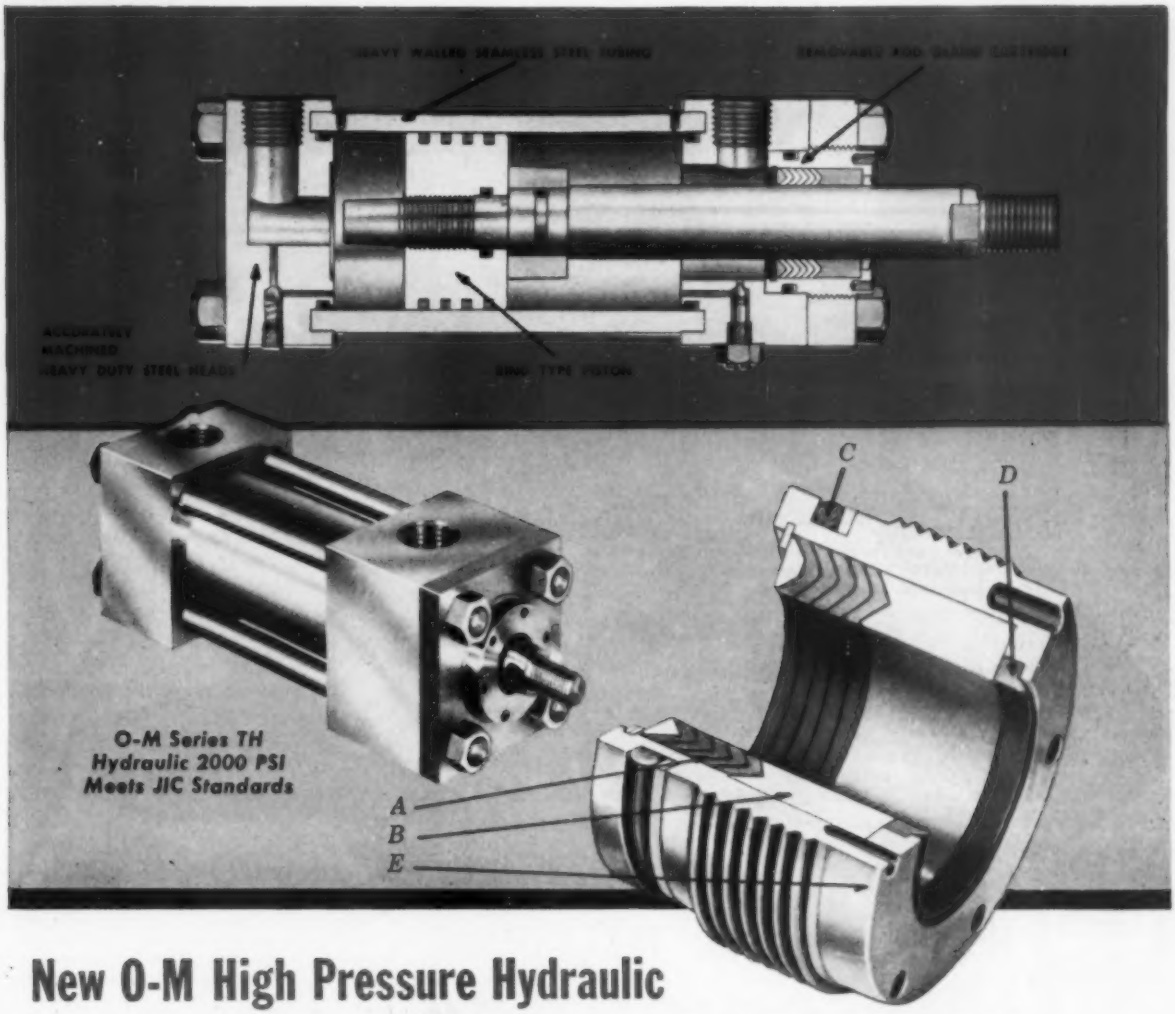

New O-M High Pressure Hydraulic Cylinder equipped with Removable Rod Gland Cartridge

The O-M-engineered removable Rod Gland Cartridge, exclusive with the O-M Series TH Hydraulic Cylinders, incorporates all the features essential to peak performance and minimum maintenance. It is constructed with a heavy wall steel shell threaded for quick, easy removal, and accurately piloted in rod head to assure perfect alignment. In most applications cartridge can be removed easily without removing mounts or the rod nuts. You simply loosen and remove with a spanner wrench.

A ***Rod Packing*** — Vee type, non-adjustable, self-compensating, rod gland packing provides multiple lip seal with excellent pressure sensitivity and long life.

B ***Rod Bearing*** — Extra long, bronze rod bearing provides large bearing surface located well forward for maximum support of piston rod.

C ***Cartridge "O" Ring Seal*** — With leather back-up washer provides positive seal and acts as friction lock to retain cartridge.

D ***Rod Wiper*** — Homogeneous lip type located well forward to prevent accumulation of dirt in pocket. Metallic scraper (AN approved) available and interchangeable with wiper.

E ***Pilot*** — O.D. of cartridge serves as pilot for cylinders mounted on rod end.

O-M Series TH High Pressure Hydraulic (oil) Cylinders — conservatively rated at 2000 P.S.I. — are available in bore sizes 1½ to 8-inch inclusive. Descriptive drawings of cylinder, mounts, mounting brackets and capacity chart are included in the new O-M Bulletin 105. Mail coupon for your FREE copy today.

ENGINEERING SERVICE — consult an Ortman-Miller representative regarding your hydraulic or pneumatic problems. His broad experience with standard and special cylinder applications is available to you without obligation. Use convenient coupon.

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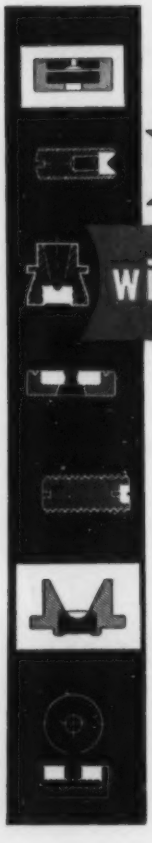

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with *Bird* jewel assemblies

Made under rigid quality-control throughout manufacture. Bird complete jewel assemblies come ready to install . . . saving production time . . . eliminating rejects . . . cutting costs.

Bird jewels are custom mounted to your specifications, by skilled craftsmen. All assemblies are thoroughly inspected . . . carefully packaged . . . shipped to meet critical production schedules.

And the cost — far less than trying to make the same assemblies in your own plant — actually only pennies to insure perfect performance for your instruments.

Why not discuss the use of jewel bearings or special assemblies with the Bird engineering staff — they are always at your service for all types of jewel bearing problems — no obligation of course.

For information on Bird Jewel Assemblies write for Bulletin 5.

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producing part of the rotor embodied in the magnesium sleeve from the large inertia-contributing part (the iron core, by assembling the core as a free-running part on the magnesium sleeve shaft). Bars of soft magnetic material are inserted in the magnesium sleeve so that the effective air-gap between the stator and the inner core is comparable to the air-gap of a conventional squirrel cage rotor.

A further improvement should be possible by using inserts of the alloy without vanadium because of the lower resistance of the former. This material was not available at the time. The effective air-gaps can also be reduced by shaping the rotor slots and inserts. This could be conveniently accomplished by production methods. It is estimated that these two slight modifications would result in a further reduction in starting time of approximately 20 per cent.

The method of construction used is adaptable throughout a wide range of motor sizes, and can be employed for d-c motors as well. The principle can also be used on other types of electromagnetic machinery, such as selsyn motors, to provide a similar improvement in response time.

Abstracted from "Low Inertia Induction Motors," by Maurice Apstein and Lester Blum, Diamond Ordnance Fuze Laboratories, Washington, D. C., presented at AIEE Winter General Meeting, New York, N. Y., Jan. 21-25, 1957.

Glass Fiber Resin Process

This centifugal molding process was born of a Korean war bottleneck. Disposable airplane gas tanks were then made of aluminum, which not only was a strategic material, but also tended to dent and cause relatively high rejection rates. In addition, aluminum's poor corrosion resistance prevented long storage of the tanks.

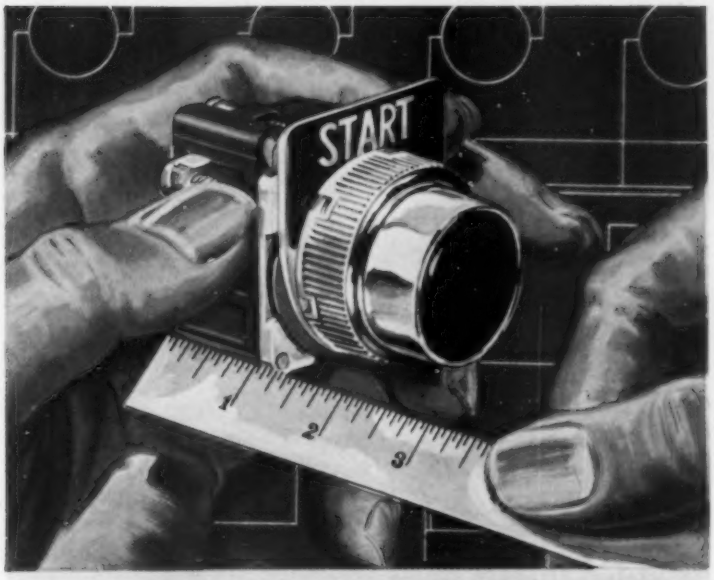
Glass-reinforced polyesters seemed a natural, but conventional methods of fabrication were too cumbersome. Result was the development of a new method using centrifugal force for the pressing of the glass fiber roving and the resin against the sides of a cylindrical or nearly cylindrical female mold.

Advantages of the process are low cost of molds which are often produced by spinning of light gage metal,

(Continued on page 382)

☆ ☆ ☆

Machine designers say these new heavy duty pushbutton units have no equal and prove it by adopting them as standard equipment



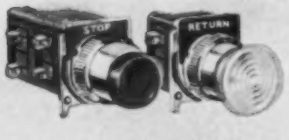
These are the world's smallest heavy duty pushbuttons. They require a behind-the-panel depth of only 1 3/32". This is 40% less space than needed by the next smallest units on the market. Double-pole contact blocks are available in all combinations of normally open and normally closed contacts. Each control circuit is electrically and mechanically isolated from the other. Each circuit is clearly identified and all terminals are color coded. Rapid on-the-job circuit additions are obtained by stacking contact block on contact block.

☆ *they install easier*

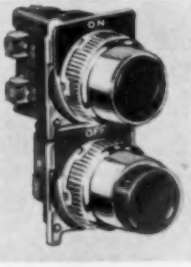
☆ *they work better*

☆ *they last longer*

Design engineers are quick to recognize that these new heavy duty pushbuttons have *everything*. There is nothing on the market like them. They are amazingly compact to require the least back-of-panel depth. They are one-hole mounting and they are oil tight. They easily provide for as many as eight separate control circuits per pushbutton, eight completely isolated heavy duty contacts either normally open or normally closed. The buttons may be flush type, the extended type or with mushroom heads. They can be black, red, yellow, green or gray. See the new one-button control station, C-H Roto-Push. See the easiest-to-install maintained-contact pushbutton attachment and the means for padlocking any of the standard pushbuttons. There are both knob and key operated selector switches in this complete line. Also matching indicating lights and the new automation safety light, PresTest. Be sure you have complete information *now*. Write today on your company letterhead for a copy of the new Cutler-Hammer Pushbutton Handbook Pub. EL-178. CUTLER-HAMMER, Inc., 1332 St. Paul Ave., Milwaukee 1, Wisconsin.



These pushbuttons may be flush type, extended type or with mushroom heads . . . in a wide range of colors for quick control identification. Standard, large, and jumbo size legend plates fit every type of operator and indicating light in the entire line.



A maintained-contact pushbutton assembly that saves more than its entire cost by installation savings. New attachment with its pushbuttons mount in minutes; no fussy adjustments. Neither alignment nor spacing of units is critical. Pushbuttons will not bind or stick; always operate perfectly.

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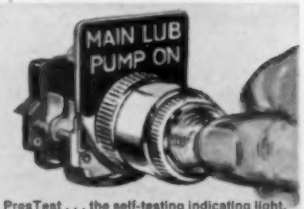
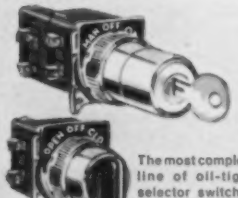
MOTOR CONTROL
C-H

The C-H one-hole mounting oil-tight indicating lights with new wide-visibility lenses are the most visible from all angles by actual light meter tests. Available in either transformer or resistor types. Lenses offered in six different colors.



PresTest . . . the self-testing indicating light. Vital to safety and proper use in machines, particularly in automation. PresTest now permits instant proof light is NOT off because of burned-out bulb. Merely pressing on the light lens disconnects bulb from its normal circuit and checks it on a test power supply. Resistor and transformer types available.



The most complete line of oil-tight selector switches on the market. Key or knob operated; two or three position. Positions may maintain contact or have spring return. Three standard contact blocks provide a wide range of circuit combinations with the use of just a single block. Unlimited circuitry by adding blocks.

Roto-Push . . . the one-button control station. One Roto-Push can provide all the control functions for which two or three separate pushbuttons would be used normally. Available in a wide range of selector and button operators, Roto-Push simplifies panel design and saves installation time to cut costs. Improves machine-operator efficiency.

Bridgeport BELLOWS AND ASSEMBLIES PERMIT GREATER DESIGN FREEDOM

Bridgeport bellows bring an extra measure of strength, safety and stability to any bellows application. And to help you realize these advantages to the fullest, Bridgeport can supply bellows in the best form for your requirements. There's a choice of single or multiple-ply construction, many different heads and ends, sizes from ¼" to 5⅞" O.D., and a wide variety of metals—brass, phosphor bronze, beryllium copper, stainless steel, monel.

With its specialized engineering staff and all-new plant, Bridgeport is also better able to integrate the engineering and production of complete bellows assemblies. The latest high-speed, precision equipment and quality control facilities enable Bridgeport to supply any assembly at lowest cost . . . with uniformly high quality.

SEND FOR BELLOWS ENGINEERING BULLETIN EP

Robertshaw-Fulton CONTROLS COMPANY

BRIDGEPORT THERMOSTAT DIVISION • MILFORD, CONN.

ability to change thickness of part without reworking the mold, and short lead time for preparation of molds. Major disadvantage is restriction to a particular class of shapes.

Abstracted from "Pastushin 'GFR' Plastic Process," by Chris Mireau, Pastushin Aviation Corp., *SPE Journal*, Dec. 1956.

Engineers Study Administration

Thousands of engineers and scientists in industry and government find themselves in managerial positions. Most of them realize that their training for management has been inadequate. This article describes how the senior engineers, scientists, and training officers of the Navy Dept., and the Engineering School of George Washington University, jointly developed a solution to this problem by organizing an after-working-hours educational program in management. Since its initiation in Feb., 1953, 13 have completed the program and have been awarded a Master of Engineering Administration degree; 274 are now actively studying for the degree.

It is recognized that there are many ways other than taking university courses after hours by which engineers and scientists may acquire managerial skills. Among those commonly used are on-the-job training and experience, individual study, and participation in professional society activities. The after-hours educational program which is described in this paper is only one means for developing the managerial skills of engineers and scientists. The following are the conditions under which such a program is most likely to succeed:

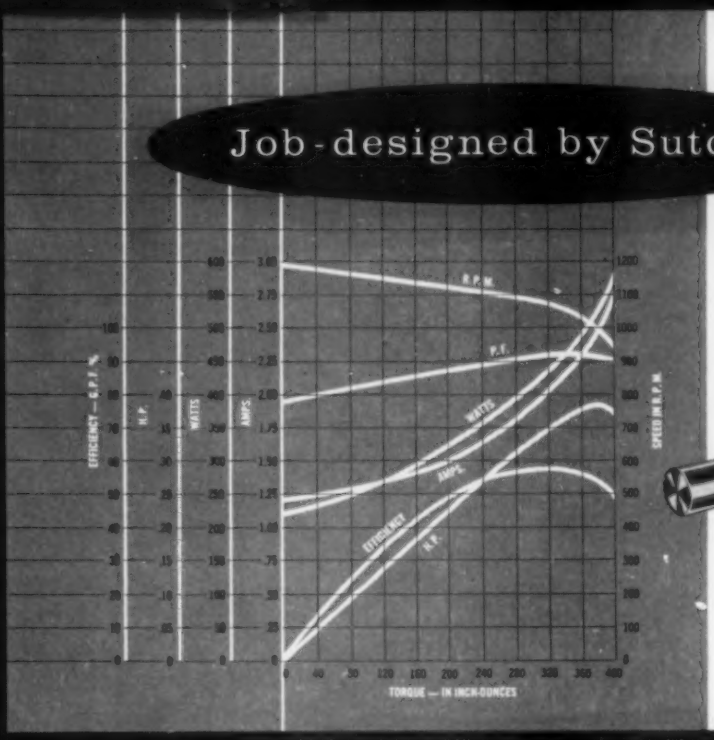
1. There must be a significant number of professional employees in the community from which the student body is to be drawn.

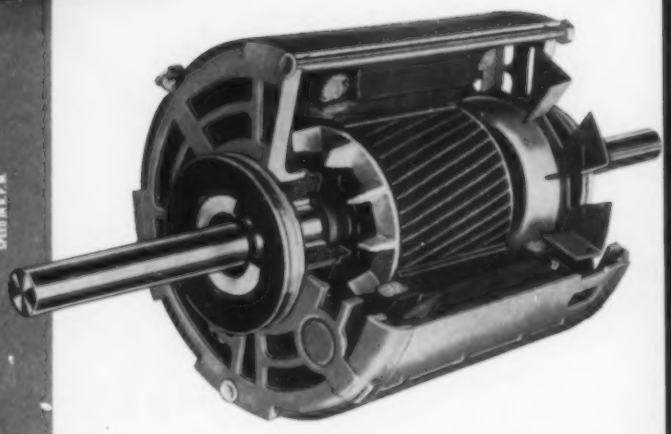
2. A nearby educational institution must be available with a faculty alert to their responsibilities for meeting the needs of the community. Leadership to co-ordinate the program and integrate the courses and instructors from several departments into a program of training in administration for professional employees is essential.

3. Management of one or more organizations, either public or private, in the commuting areas must recog-

(Continued on page 386)

Job-designed by Sutco...





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Variable to specific design requirements

Economically, there is only ONE motor that will give superior performance in any ONE given application.

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In shaded-pole and permanent split-capacitor motors our highly automated production methods – in the hands of highly skilled personnel – assure you higher efficiency, cooler operation and longer life for your products – at an economical cost.

Model Number	H. P.	R. P. M.	Approx. Watts In	Approx. AMPS.
6C80	.333	1075	440	2.1
6C72	.290	1075	390	1.9
6C64	.250	1075	350	1.7
6C56	.200	1075	280	1.35
6C48	.167	1075	230	1.1
6C40	.125	1075	180	0.85
6C32	.1000	1075	150	0.75
6C24	.0667	1075	110	0.60

* *Ratings shown are for 230 volts*

For the most economical job-designed solution to your particular application, write to:

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THE O. A. SUTTON CORPORATION, INC., Wichita, Kansas

SHADED POLE MOTORS

2-Pole Type 2A
up to 1/60 H.P. – Speed 2,500 to 3,200 R.P.M.

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up to 1/25 H.P. – Speed 1,550 R.P.M.

4-Pole Type 4D
up to 1/8 H.P. – Speed 1,550 R.P.M.

6-Pole Type 6D
up to 1/4 H.P. – Speed 1,050 R.P.M.

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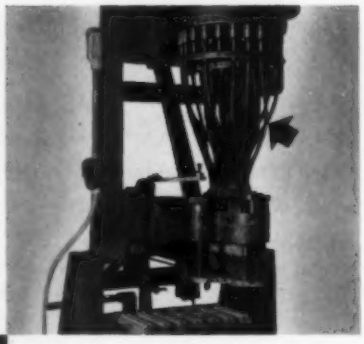
The manufacturer of this multiple spindle drill press finds that S.S. WHITE FLEXIBLE SHAFTS allow a wide range of positions for different drilling jobs.

This is only one example of the versatility . . . efficiency . . . and freedom S.S. WHITE FLEXIBLE SHAFTS are bringing to hundreds of industrial designs. The restrictions imposed by rigid shafting are eliminated. With flexible shafts you position power sources . . . driven members . . . controlled parts to better advantage. By simplifying methods of connection and adapting, costs can be reduced. Assembly is cheaper . . . alignment problems are eliminated . . . and product efficiency is often greatly improved!

Consider your own product. Chances are, S.S. WHITE FLEXIBLE SHAFTS are the simple, economical answer to your power drive and control problems. S.S. WHITE FLEXIBLE SHAFTS are noted for quality, performance and dependability. For more information and expert assistance in selecting and applying an S.S. WHITE flexible shaft to your product, just write to



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USEFUL DATA on how to select and apply flexible shafts! Write for Bulletin 5601.

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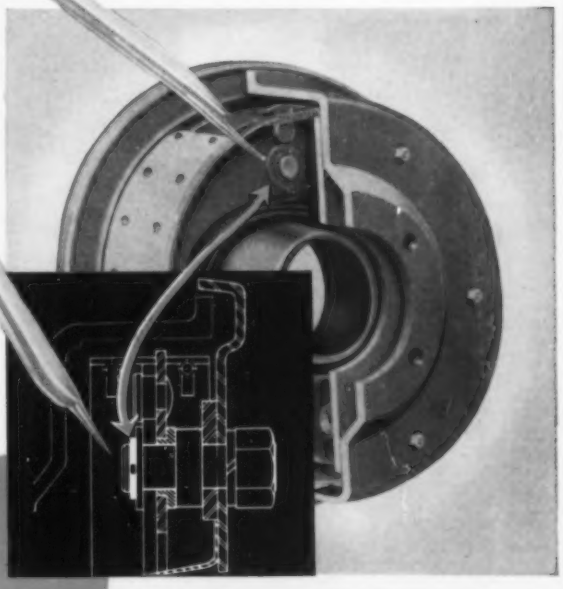

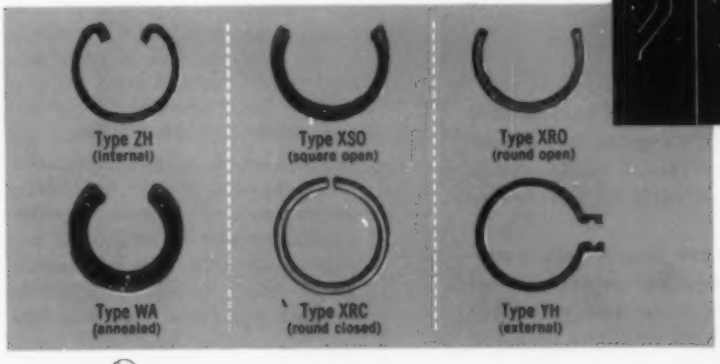

TYPICAL APPLICATION—
A 25% saving in assembly cost resulted when retaining rings were employed in this electric brake. Elimination of a nut, the threading of one end of shaft and reduction of 8" in the length of an anchor pin effected additional important cost reductions.

Consult a NATIONAL Engineer— He has the facts on thousands of successful applications and will be happy to discuss your specific design problems at your convenience. Just call or write, today!

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West Virginia Special Sections

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TOWMOTOR
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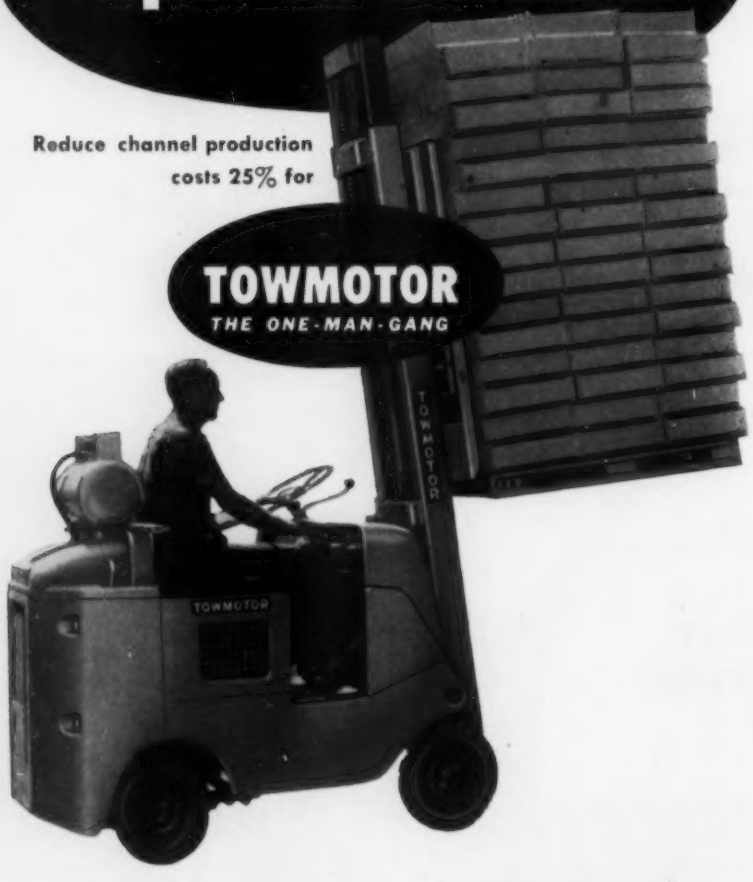

Originally, Towmotor mast assemblies required considerable planing and machining. West Virginia's engineering consultants helped develop a special rolled section for Towmotor that resulted in lowering production costs by twenty-five per cent.

West Virginia Special Sections have helped reduce production and labor costs of many major companies. A West Virginia engineer will be happy to assist you with your problems. He may be able to save your company time and money through the development of *Special Sections . . . Rolled to Your Needs and Specifications by:*

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nize a need for managerial development and give it whole-hearted support and leadership. Local organization may find it desirable to give financial support in order to establish the program and insure its stability. This assistance might be an annual grant to the educational institution, the endowment of a chair in engineering administration, the establishment of scholarships, or the payment of tuition for employees.

4. A substantial number of engineers or scientists in the area must recognize that more knowledge about management would increase their effectiveness and opportunities for greater responsibilities.

5. Responsibilities for co-operating agencies, educational institutions and students must be carefully defined.

6. Complete understanding among all who have a part in the program must be achieved through the full use of all avenues of communication.

Abstracted from "Engineers Study Administration," by K. C. Harder, Office of Naval Research Dept. of the Navy, 17th & Constitution Ave., N.W., Washington 25, D. C., ASME Paper No. 56-A-96, presented at ASME Annual Meeting, N. Y., Nov. 25-30, 1956.

The Human Factor in Machine Design

The human factor operates in two quite different ways in accident causation. First there is the common human failure to work in a safe manner. Familiar examples are: standing under a crane, operating a saw with guard removed, failing to wear goggles during a grinding operation. Safety engineers attempt to minimize the consequence of unsafe practices by the provision of mechanical safeguards and other safety measures which protect the worker despite his own actions. More important, however, because they are directed toward the basic cause, are such preventive activities as selection, placement, training and supervision of personnel, individual and group education and other measures which operate directly on those exposed to risk to improve their work methods and thus reduce the frequency of unsafe acts.

The second way in which the human factor operates to increase the accident potential is more directly

(Continued on page 390)

NEW

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HOWARD MODEL 9200

INDUCTION MOTOR

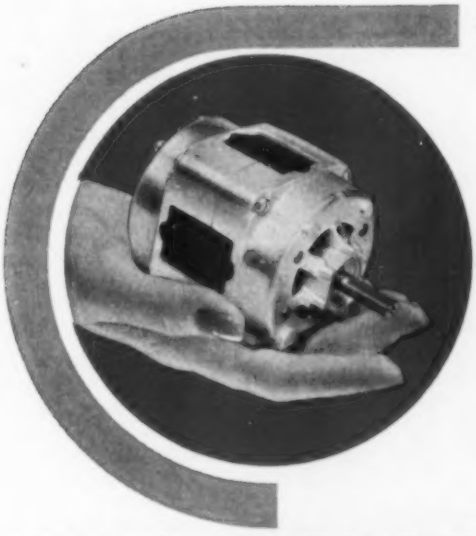
Now available from Howard Industries, Inc. is an exclusive Miniaturized Induction motor with *all* the features of an ultra modern power motor for use in tape recorders, communication equipment, office machines, turn table, movie projectors, air craft, instruments, electronic devices and many more applications.

Special design of magnetic and electrical circuits (24/20 slots), sinusoidally distributed windings, internal rotor slotting combined with unique mechanical features result in exceptionally quiet operation, low level magnetic hum, reduced external magnetic field, low temperature rise, minimum cogging and hunting.

Howard's Model 9200 has been rated by experienced engineers as the finest small induction motor on the market.

Performance ratings of these motors are outstanding, comparable to those of considerably larger frame sizes. For complete details, engineering drawings and samples, write, wire or phone HOWARD today. ●

unusual power in a small frame size



HOWARD MODEL 9200 Permanent Split Capacitor, Single Phase, 50/60 Cycle Induction, Torque, Synchronous Type—Also available in two or three phase designs.

PERFORMANCE COMPARISON TO CONVENTIONAL MOTOR OF THE SAME OUTPUT RATING

reluctance synchronous single phase permanent capacitor type

	Good Reluctance Motor	Howard SWC-9214 Motor
HP	1/75	1/75
Volt	115	115
C.P.S.	60	60
R.P.M.	1800	1800
Capacitor	2.5 MFD	2.5 MFD
Load Torque	7.5 oz. in.	7.5 oz. in.
Line Amps (input)	.37	.33
Line Watt (input)	36	34
Power Factor	85%	90%
Efficiency	27.7%	29.5%
Temperature Rise °C	36.5°C	26.3°C
Starting Torque	10 oz. in.	11 oz. in.
Pull-in Torque	9 oz. in.	11 oz. in.
Pull-out Torque	9.5 oz. in.	12 oz. in.

CONSTRUCTION SPECIFICATIONS:

General: Open, self ventilated, versatile mount construction. Laminations are stamped from high grade silicon electrical steel. The stator core is housed inside a rigid framework consisting of the two aluminum die cast end brackets telescoped into each other with both rabbets precision machined from bearing bores.

This type of construction eliminates the danger of bending out of shape of the stator structure which is possible in a conventional skeleton type motor.

Bearings: Motors can be supplied with porous bronze sleeve bearings of self aligning or rigid type. An adjustable thrust and end play device is provided with each motor for horizontal, vertical, or thrust loading. With sleeve bearings, large felt oil reservoirs are provided. At request, motors can be supplied with permanently lubricated sealed or shielded ball bearings.

Mountings: Motor frame is designed to permit 6 types of mountings:

Rigid pad or base	Flange mounting
Recessed pad	Extended nut or thru bolt
Resilient ring (small and large size)	Face mounting

Frame Size: 2⅛ x 2⅛ with overall length of 4 1/32 for 9210 frame and 4 13/32 for 9214 frame.

Ratings: Single phase, 115, 50/60 cycle, permanent split capacitor, continuous duty, 40° C. rise and 2 & 3 phase 230 volts, 50 to 60 cycles.

Induction Type: (RWH 9210 & 9214) 2, 4, 6, & 8 Poles
HP Range: 1/300 to 1/30 Hp

Torque Motors: (RWC 9210 & 0214) 4 & 6 Pole
Torque Range: 5 to 12 Inch-Ounce of Stalled Torque Cogging of 6 pole motor + or −2%

Reluctance Synchronous: (SWC 9210 & 9214) 2 & 4 Pole
HP Range 1/250 to 1/50 HP

Hysteresis Synchronous: (HWC 9210 & 9214) 2, 4, 6, & 8 Pole
HP Range: 1/250 to 1/75 HP

HOWARD MOTORS: *Universal & D.C.—1/200 to 1/2 HP, Shaded Pole—1/2000 to 1/8 HP, Induction—1/1400 to 1/4 HP, Servo Motors · Gear Motors · Blowers*

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Special Reports On Finishing Non-Ferrous Metals

NUMBER II—Paint Base, Corrosion-Resistant Finishing with Iridite

WHAT IS IRIDITE®?

Briefly, Iridite is the tradename for a specialized line of chromate conversion finishes. They are generally applied by dip, some by brush or spray, at or near room temperature, with automatic equipment or manual finishing facilities. During application, a chemical reaction occurs that produces a thin (.00002" max.) gel-like, complex chromate film of a non-porous nature on the surface of the metal. This film is an integral part of the metal itself, thus cannot flake, chip or peel. No special equipment, exhaust systems or specially trained personnel are required.

Chromate conversion coatings are well known and accepted throughout industry as an economical means of providing corrosion protection, a good paint base and decorative finishes for non-ferrous metals. However, continued developments have been so rapid and widespread that many manufacturers may not be completely aware of the breadth of application of this type of finish. Hence, this digest of current information; to bring you up to date on the many ways in which you can obtain proper surface preparation for painting and increase product durability with a single multi-purpose chemical pretreatment. Report I on decorative, corrosion-resistant finishes and Report III on chemically polished, corrosion-resistant finishes are available on request.

First, it is an accepted fact that metal surfaces should be prepared before painting to make possible an efficient paint system. Naturally, this preparation should provide for good initial paint adhesion. Chemical treatments have proved extremely effective in this respect, particularly those of a neutral or preferably acid nature. Further, to be most efficient, chemical treatments should provide a non-porous barrier to maintain adhesion by sealing the metal from the paint and moisture. They should also provide a self-healing film which prevents lateral corrosion in the event that bare metal is exposed through scratching.

The Iridite chromate conversion coatings meet all these requirements. Iridite is a chemical conversion treatment for surface preparation. It provides initial paint bonding by molecular adhesion. It is acid in nature and produces a film that is gel-like and non-porous in structure. Thus, the Iridite film effectively seals the metal from the paint and from moisture penetration. Because the film contains certain relatively soluble constituents, it will protect areas scratched through to bare metal and prevent lateral corrosion. This is accomplished by a gradual leaching of these constituents into the damaged area.

Further, because of its gel-like, non-crystalline nature, the Iridite film will not affect the appearance or texture of the paint film, nor will it dust or powder to mar the painted surface. Because the film is non-porous, paint coverage is increased, thus substantial savings in paint costs will be realized. In addition, treated parts may be stored for long periods of time prior to painting without the risk of entrapped moisture causing blistering when painting.

Iridite chromate conversion coatings are widely used with equal ease and success under both baked and air-dried paint systems. While the actual adherence properties of the Iridite film do not increase appreciably with its thickness, corrosion protection does. The protection of the Iridite film is proportionate to its thickness and should be taken into consideration when selecting the Iridite to meet your needs. However, it is sometimes necessary to sacrifice maximum corrosion protection for appearance when a finished part is to be only partially painted. For example, it may be desirable to use a thin, clear, bright Iridite film if the unpainted areas must present a chrome-like appearance. A typical case is that of instrument housings on which the exterior is painted and the inside left unpainted.

On the other hand, if all surfaces of the product are to be painted and maximum corrosion protection is required, the heavier and most protective Iridite films should be used. For example, all surfaces of zinc die cast fruit juicers are finished with a highly protective Iridite film prior to painting to provide maximum resistance to the corrosive action of fruit juices.

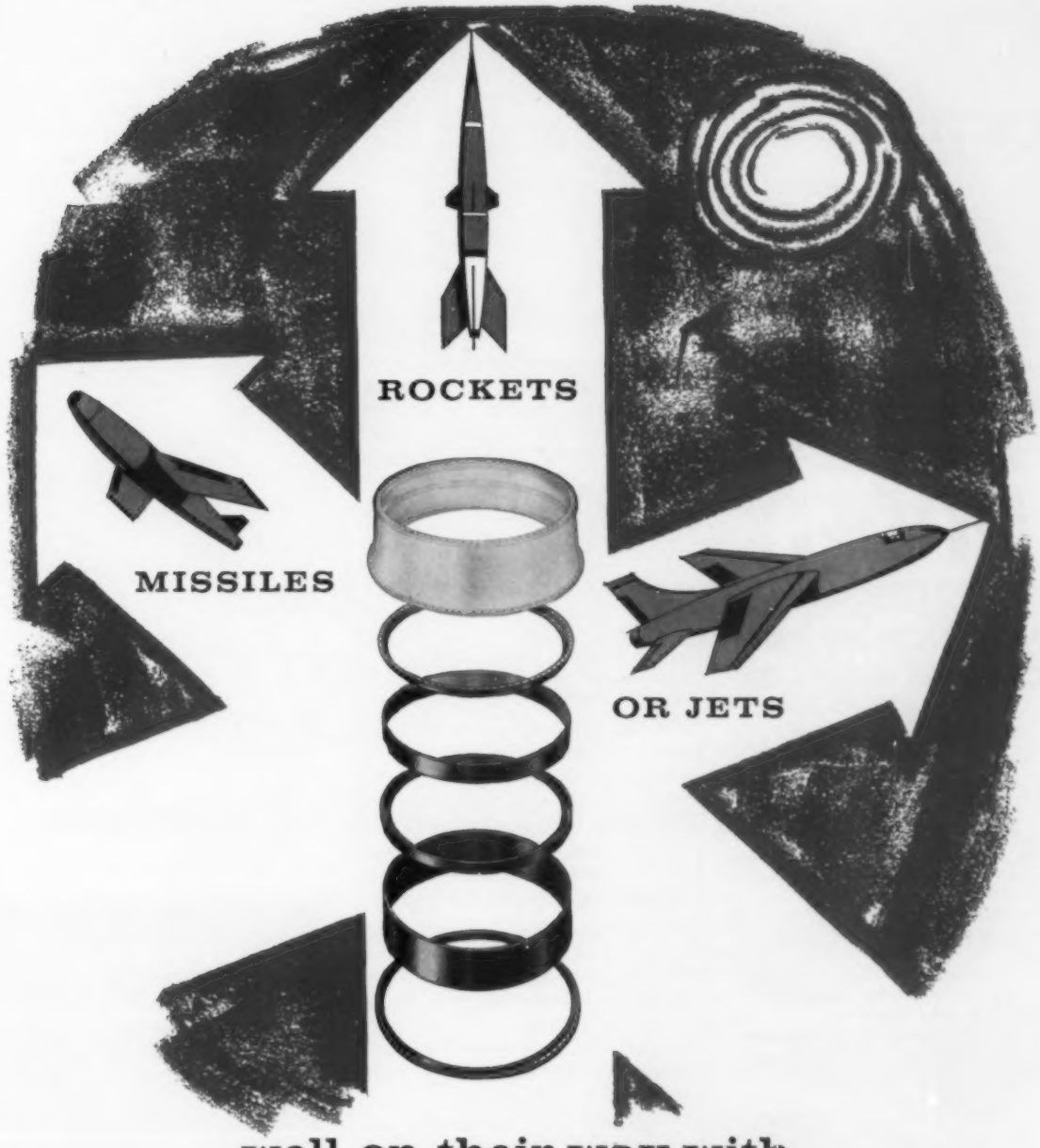
Iridite finishes are now available for all commercial forms of the more commonly used non-ferrous metals, including zinc, cadmium, aluminum, magnesium, silver, copper, brass and bronze. In addition to providing an excellent base for paint, the Iridite films also have high decorative value when used as final finishes in themselves.

These films can produce a wide variety of pleasing appearances including clear bright, iridescent yellow, bronze, olive drab and brown. In addition, many films can be modified by bleaching or by dyeing. Among the dye colors available are various shades of red, yellow, green, blue or black.

In planning or designing, you should consider the many other characteristics of Iridite finishes which may enter into the specific problem. In addition to their functions as protective and decorative finishes, and as bases for organic finishes and bonding compounds, Iridites have low electrical resistance. Some can be soldered and welded. The film does not affect the dimensional stability of close tolerance parts.

Iridites are widely approved under both Armed Services and industrial specifications because of performance, low cost and savings of materials and equipment.

You can see then, that with the many factors to be considered, selection of the Iridite best suited to your product requires the services of a specialist. That's why Allied maintains a staff of competent Field Engineers—to help you select the Iridite to make your installation most efficient in improving the quality of your product. You'll find your Allied Field Engineer listed under "Plating Supplies" in your classified telephone book. Or, write direct and tell us your problem. Complete literature and data, as well as sample part processing, is available. Allied Research Products, Inc., 4004-06 East Monument Street, Baltimore 5, Maryland.



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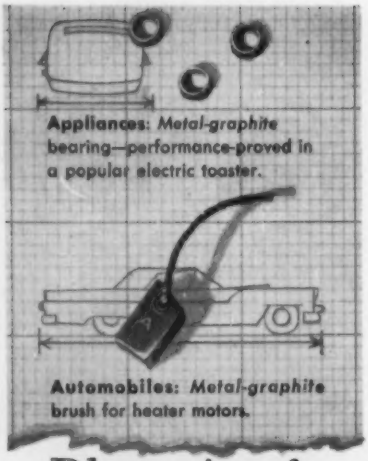
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related to engineering. This is the inherent accident potential of the job itself, with the stresses which it imposes on the worker and the ways in which they operate to cause a failure in the smooth and safe functioning of the man-machine system. The accident risk is increased, for example, when the operator assumes an awkward position to perform a particular task. This risk can be minimized by training, but it is improper to charge a consequent accident to human failure when, in fact, the need for such awkward performance can be eliminated by proper design, such as substitution of mechanical for manual lifting, better location of levers and pedals, or by keeping the required operating forces within the safe tolerance limits of the operator.

An accident which results from inadequate illumination should not be charged to an unsafe act on the part of the operator, even when the added risk imposed by poor lighting and the obvious necessity for extra care are fully recognized. The increased accident potential on hot jobs must be viewed as the consequence of too much heat stress on the operator and the proper correction is obviously in the direction of heat control rather than cautioning workers to avoid excessive exposures or to work at a slow pace.

Failing to wear a respirator in a hazardous atmosphere is an example of human failure. The need for the respiratory protection in the first place, however, is an example of engineering failure to control the dangerous atmospheric contaminant.

Successful job performance may require a speed of action which is excessive in relation to human reaction; the demands upon visual capacities, such as speed of vision, visual acuity, accommodation to changing distance of focus and depth perception, may be excessive; the visual field may be too restricted; the order and manner in which essential information is presented to the machine operator may be confusing, and meter dials may be difficult to read on account of improper design or placement or poor illumination.

The principles and procedures of human engineering provide the basis upon which to develop an area of

(Continued on page 394)

The Clentimack transmission is a variable speed transmission for the control of any process or machine requiring variable speed. Adjustments may be made manually or automatically over a complete range 8.1 — while the unit is at a standstill or in motion.

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VARIABLE

SPEED

TRANSMISSION

Highly successful—proven in operation, these dependable transmissions are in use in many industries. A number of these units have operated continuously for five years without requiring maintenance or repairs.

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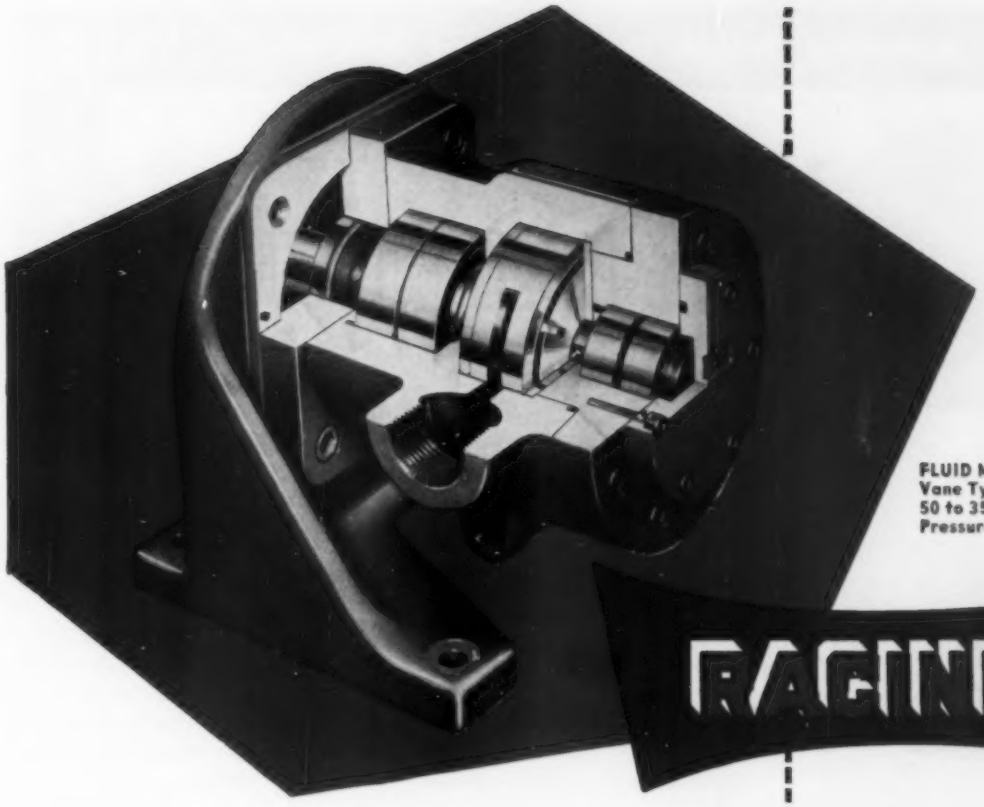

FLUID MOTOR
Vane Type
50 to 3500 rpm
Pressures to 1500 psi

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Note its simplicity and the minimum of moving parts, all of which are self-compensating for wear. Extra capacity bearings, heavy-duty shaft, tool steel vanes and alloy steel rotors, all contribute to efficient, dependable performance and maximum operating life.

RACINE Vane Type FLUID MOTORS are available in several sizes with maximum output to 22 horsepower. Speeds from 50 to 3500 RPM — operating pressures to 1500 PSI.

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Up to 5000 psi
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RACINE HYDRAULICS & MACHINERY, INC.
2072 Albert Street
RACINE, WISCONSIN, U.S.A.

exacting design specifications deserve

Actual Size

SYNCHRON®
TIMING MOTORS

THE QUALITY BUILT SYNCHRON LINE BY HANSEN

WRITE TODAY FOR FULL INFORMATION

8 IN. OZ. STANDARD TIMING MOTOR
An industry standard for timing machines, time switches, air conditioning and heating controls, action displays, signs, recording thermometers and timing devices. Guaranteed to pull 8 in. oz. direct load continuously at 1 r.p.m.

NEW 1 R.P.H. TIMING MOTOR
Especially developed for "slow-motion" timing applications. Eliminates need for extra reduction gears between 1 r.p.m. and 1 r.p.h. in intermittent time trains. Lifetime lubrication, enclosed and maintenance free. Guaranteed 20 in. oz. at 1 r.p.h. (1/60 r.p.m.)

FOR DEPENDABLE POWER IN CONTROLS AND TIMING DEVICES . . . CHOOSE A PRECISION - MADE TIMING MOTOR FROM THE SYNCHRON LINE . . . BY HANSEN

Here's why you can put your trust in SYNCHRON TIMING MOTORS. Synchron's precision engineering and quality controlled production assure your design of dependable, trouble-free power. Quality guaranteed by 51 individual lab tests and inspections, Synchron timing motors have proved their worth in countless power applications. You can always depend on Synchron for dependable torque power for your designs.

"Workhorse of the industry"

Synchron synchronous motors operate smoothly, evenly in any position; at temperatures from −40° to +140°F.; start instantly under load; pull up to 20 in. oz. at 1 r.p.m. 42 speeds available; 0.8 r.p.m. to 600 r.p.m.

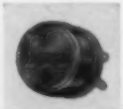
20 IN. OZ. HIGH TORQUE MOTOR
Ideal for timing motor applications requiring continuous high torque power. Dependable, instant starting, durable and accurate. Operates in any position. Guaranteed 20 in. oz. at 1 r.p.m.

SYNCHRON CLOCK MOVEMENTS
Split-second accuracy and long wearing construction, never needs oiling. Front, rear or bottom set, with or without dustproof case. Simple mounting cuts production and assembly costs.

MAGNATORC D.C. MOTOR
Designed originally for World War II aircraft instrument and radio control mechanisms. Now being used for commercial applications demanding exceptional durability and dependability.

Synchron timing motors in all speeds available for prompt delivery

SYNCHRON®



SYNCHRONOUS MOTORS, TIMING MACHINES, CLOCK MOVEMENTS, MAGNATORC D.C. MOTORS

HANSEN MFG. CO., INC.
OUR 50TH YEAR

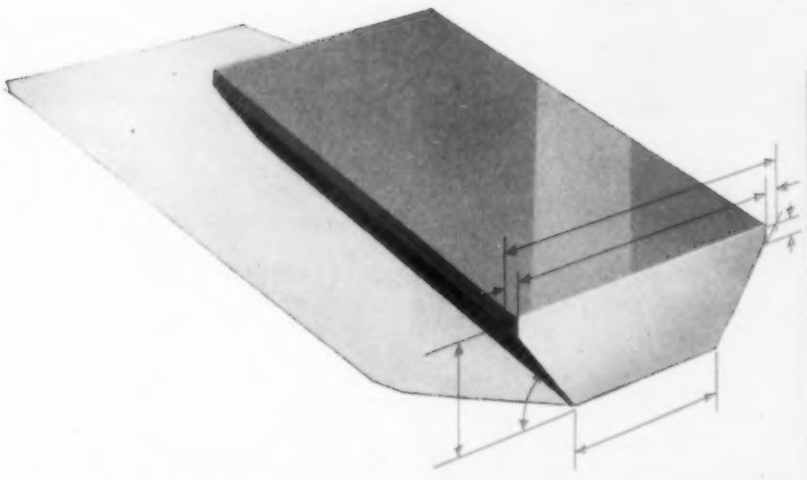
PRINCETON 5, INDIANA

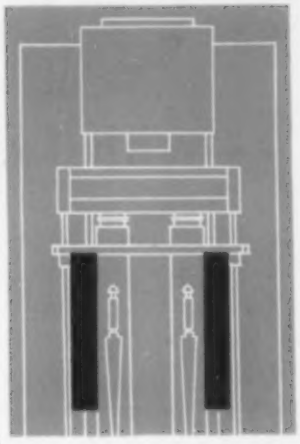
HANSEN REPRESENTATIVES: The Fromm Co., 5254 W. Madison St., Chicago, Ill. R. H. Winslow Assoc., 123 E. 37th St., New York, N. Y. Electric Motor Engineering, Inc., 8255 Beverly Blvd., Los Angeles 48, Cal. and 3907 Lyon Ave., Oakland, Cal. H. C. Johnson Agencies, Inc., Rochester, Buffalo, Syracuse, Binghamton, New York.

J&L hot extruded cold drawn cam rail section

cuts machining cost

from $1.75 to 75¢ per foot





"This part was previously milled from a cold rolled section at a cost of approximately $1.75 per running foot. Our present cost is 75¢ per foot using your cold drawn extruded section." This machine tool manufacturer cut his production costs by buying these exclusive J&L steel sections. You can obtain similar savings:

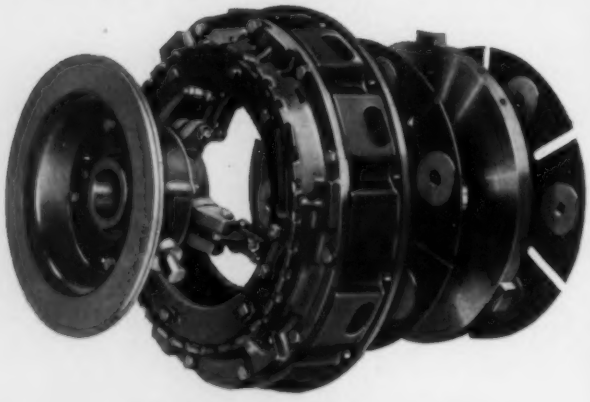
1. Eliminate machining and finishing operations.
2. Reduce scrap losses almost to zero.
3. Eliminate cost of casting and forging intricate sections.
4. Reduce inventories because extrusions are quickly available.

Investigate this new production technique for your shape profiles—within present limits of a design which can be inscribed in a three-inch circle. You'll surely boost production, cut overall cost. For complete details write to the Jones & Laughlin Steel Corporation, Dept. 409, 3 Gateway Center, Pittsburgh 30, Pa.

Jones & Laughlin
STEEL ...a great name in steel

ROCKFORD

Double Plate Clutch Provides More Torque



- With Less Size

Used in a large crawler-type tractor, this Double-Plate ROCKFORD Morlife CLUTCH (Utilizing two MORLIFE® plates—equipped with button type facings) provides 100% more torque capacity than previous clutches of same diameter.

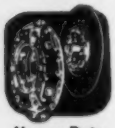
400% more service life and 50% more heat resistance are other features of this Heavy-Duty ROCKFORD Morlife CLUTCH.

A brake plate is mounted on the heavy-duty, ball bearing type release sleeve.

If you have a heavy-duty vehicle in the planning stage, it will pay you to learn about these and other advantages of this new clutch—before you design the drive line. A design study of your present drive lines might indicate advantages of using this ROCKFORD CLUTCH. For information write Department D — or

Small Spring Loaded

Automotive Spring Loaded


Heavy Duty Spring Loaded

Oil or Dry Multiple Disc

Heavy Duty Over Center

Light Over Center

Power Take-Offs

Speed Reducers

SEND FOR THIS HANDY BULLETIN

Shows typical installations of ROCKFORD CLUTCHES and POWER TAKE-OFFS. Contains diagrams of unique applications. Furnishes capacity tables, dimensions and complete specifications.

ROCKFORD Clutch Division BORG-WARNER

209 Catherine St., Rockford, Ill., U.S.A.

Export Sales Borg-Warner International — 36 So. Wabash, Chicago 3, Ill.

ENGINEERING B-W PRODUCTION

CLUTCHES

safety engineering which has for its objective the elimination from industrial machinery of all possible stresses which, otherwise, act adversely upon the human operator to increase the accident potential in the man-machine system.

Abstracted from "The Human Factor in Machine Design," by Prof. T. F. Hatch, University of Pittsburgh, Pittsburgh, Pa., ASME Paper No. 56-A-46, presented at ASME Annual Meeting, N. Y., Nov. 25-30, 1956.

Standards for Filing Engineering Drawings

Engineering drawings represent not only the expenditure of many hours of labor, but also years of concentrated experience and creative effort. In many respects they mirror the technical history of an organization. The drawings, however, are of more than historical worth, for they represent the lifeblood of a technical organization. They are the culmination of hours and years of creative thought and experiment. The ability of an organization to draw upon these assets is of prime importance to management. The essential and primary problem is how to file the drawings so that they are protected properly—and at the same time, readily available for use. Another important consideration is to keep filing costs within reasonable limits. The problems are not easily solved. Many factors must be considered—types of material used for the drawings, their sizes, individual requirements and preferences and, of course, the types of equipment available for filing. Because the problem of filing engineering drawings has many ramifications, all of which require considerable discussion, this paper is limited to the proper utilization of filing equipment.

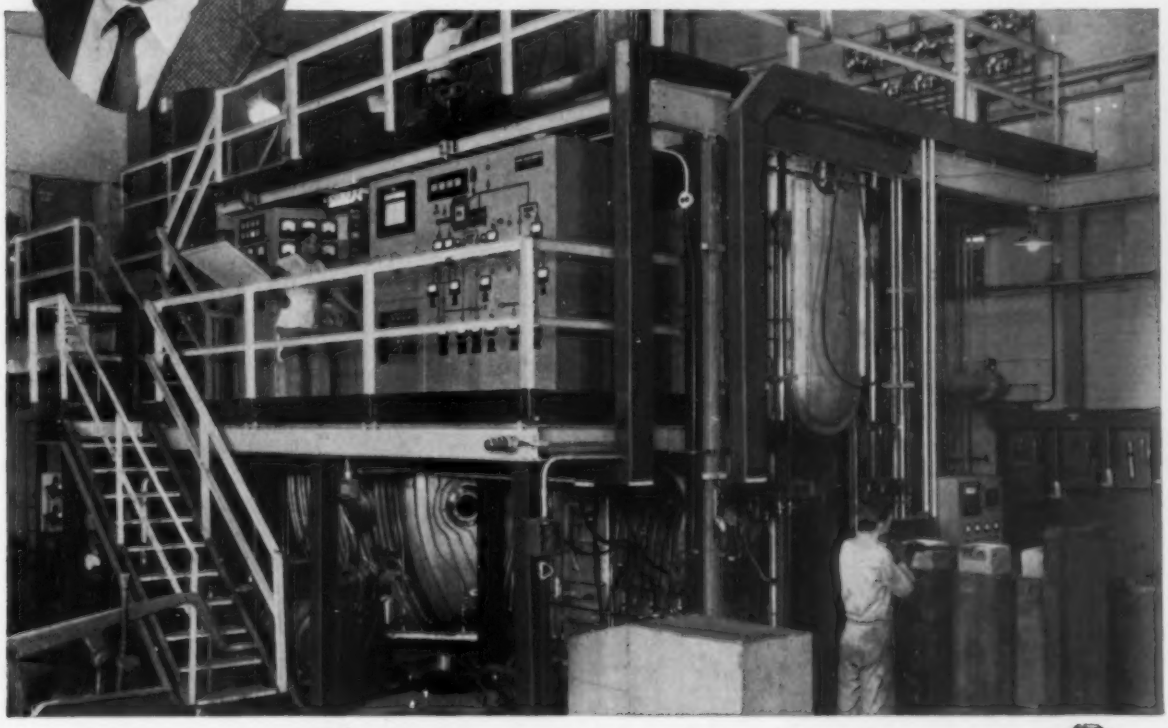
The many types of equipment currently available satisfy most needs and preferences. On the basis of the study completed by the National Records Management Council, the following conclusions may be drawn:

1 Each individual must, in the final analysis, rate the equipment for his own particular set of conditions and preferences. The rating scale can only be used as a guide for those faced with the problem of selecting storage equipment for engineering drawings.

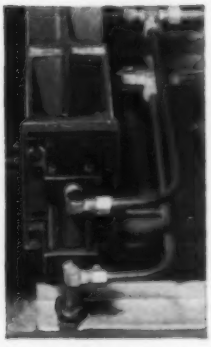
(Continued on page 398)

"Our experience demonstrated that hydraulic line rupture can occur in proximity to molten metal without fire when Cellulubes are used . . ."

Mr. Arthur E. Franks of Vacuum Metals Corporation, Syracuse, N.Y.



". . . this is why fire-resistant Celanese Cellulube hydraulic fluid is in use in the world's largest vacuum furnace at Vacuum Metals Corporation."



Hydraulic Controls on the world's largest vacuum furnace

In designing the hydraulic controls for its 2500-pound vacuum melting furnace, Vacuum Metals selected Cellulube hydraulic fluid because of its fire resistance and low vapor pressure characteristics. Laboratory tests and operating experience demonstrated that the unique combination of Cellulubes' properties made it the ideal material for this application.

These findings are typical of Cellulubes' performance during continuous operation under critical conditions. As hydraulic fluids, Cellulubes reduce the dangers of fires and explosions caused by line breaks or other equipment failures. As air cylinder lubricants, Cellulubes prevent the formation of excessive carbon deposits—the main source of compressor fires and explosions.

Available in 6 controlled viscosities, Cellulubes can be supplied to meet exacting requirements in the replacement of flammable fluids presently in use. Play it safe, write for complete data and technical assistance. Celanese Corporation of America, Chemical Division, Dept. 547-C, 180 Madison Ave., N. Y. 16.

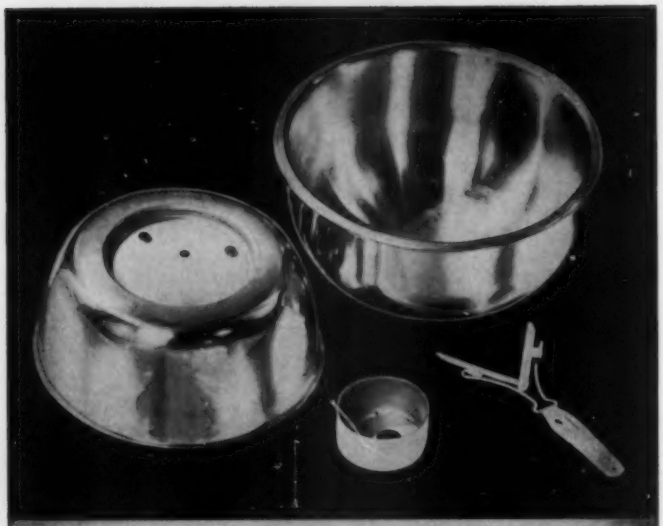
Celanese® Cellulube®

Celanese CHEMICALS

You can draw and form them LITTLE

. . . . . .

or fabricate them BIG



with the new A-L low-nickel STAINLESS GRADES

WRITE FOR THE ASSISTANCE YOU NEED

1. TECHNICAL STUDIES #3"

. . . essential information on the composition, properties, fabricating methods and applications of AL chromium-manganese, low-nickel stainless steels. *Write for your copy.*

2. TEST SAMPLES

. . . We'll be glad to supply engineering assistance, and actual samples of these 200-Series steels for testing under your processes and conditions.

ADDRESS DEPT. PE-87

In the top photograph, the fabrications you see are a mixing bowl, a tea-kettle base, a lock case and a patented shoe fastener: all made of A-L Type 201 or 202 chrome-manganese low-nickel stainless. The finish is good, the steel handled the same in the presses as Types 301 or 302, and similar drawing, buffing and polishing procedures were followed.

As in the lower illustration, the chrome-manganese low-nickel grades are being used also for fabrications as large as truck trailers and railroad coaches. Again, forming qualities and weldability present no problems, and results are entirely satisfactory.

Sum it all up and this is the answer: you *won't* encounter any particular differences in fabricating the 200-series of stainless steels . . . you *will* find some advantage in price, and a very important factor of much greater availability in times of nickel shortage. ● Why not take advantage of our pioneering experience with the low-nickel grades—let us help you use them. ***Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa.***

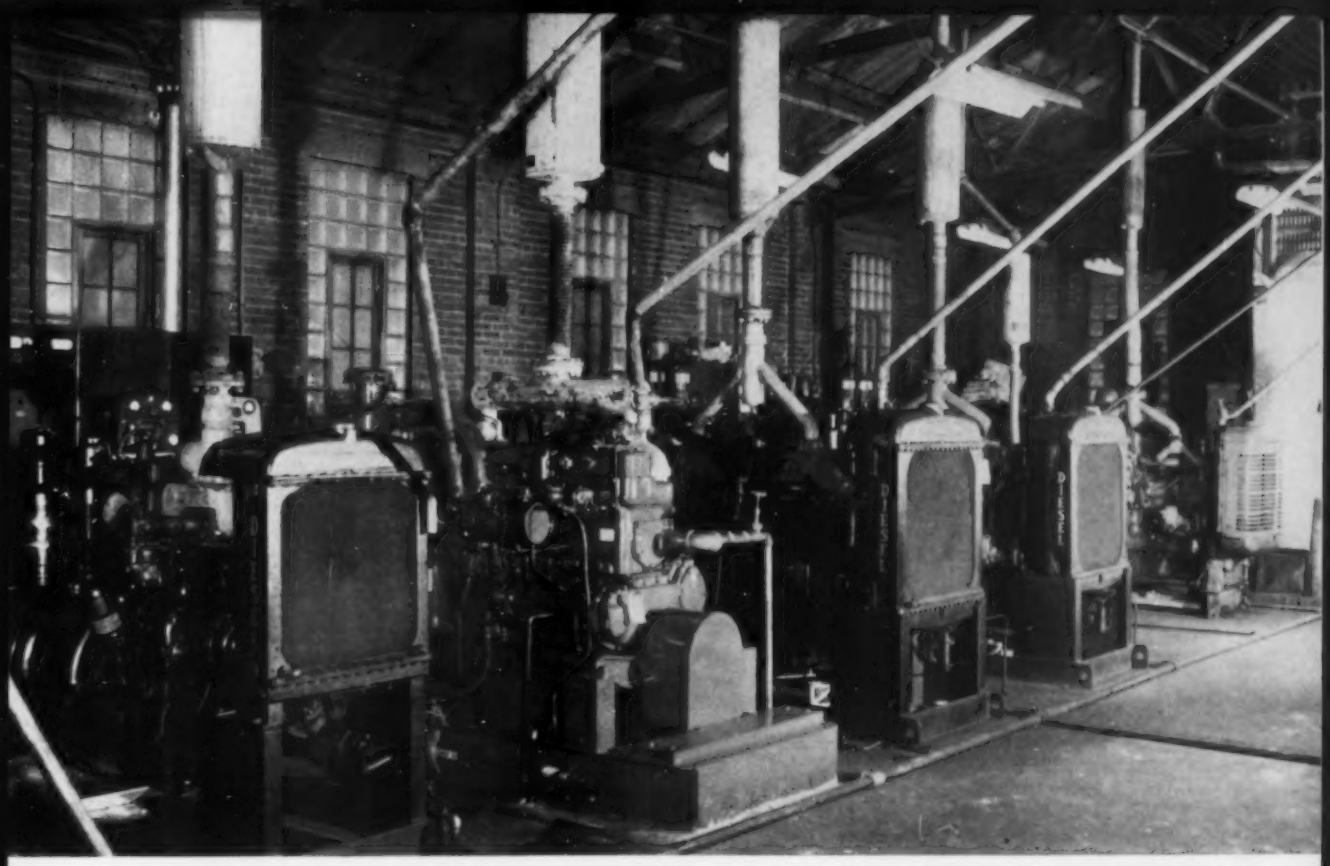
WSW 6080

For Stainless Steel in ALL Forms—call

Allegheny Ludlum

AL STAINLESS STEEL

Warehouse stocks carried by all Ryerson Steel plants



Here are five of eight International diesels that have driven Ready-Power generators in Standard Carbon's powerhouse for a total of 107 engine service-years. The UD-1091, second from left, is seven months old. The other 7 power units average over 15 years each of dependable service.

8 Ready-Power International driven GENERATORS CUT ELECTRIC COSTS 43%

Standard Carbon's International power units going strong after 107 service-years

The Standard Carbon Co., Steubenville, Ohio, is a nationally famous manufacturer of carbon brushes.

President W. F. Rogers fills in these details of their powerhouse operation: "We started in business in 1928 operating on purchased power. Back in 1939 we set up our own powerhouse—starting with an International PD-80 diesel power unit on a 48KW Ready-Power generator. Shortly thereafter we bought two more of these units. Today our eight Ready-Power generators are all driven by Internationals—*and we are generating power for 43% less than we pay for the 15% of the electricity we still purchase.*"

Supt. George Rogers adds: "Good service with only minor repairs sums up our experience with Internationals. Our Internationals have totalled 107 service-years—an average of over 13 years per engine. And only recently I rebuilt one of the 17-year-olds for the first time and still was able to reuse many of the original parts including the crankshaft!"

This long-life, low-cost power will help you protect the reputation of your products. Get it by specifying any of 16 International diesel or carbureted engines ranging up to 216 horsepower. Call or write us. Experienced sales representatives, sales and design engineers will assist you with product data and power recommendations that will help solve your engine problem. Then you'll have power that will increase the productivity of your products.

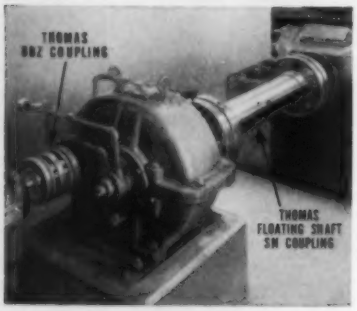
INTERNATIONAL®

International Harvester Company
180 N. Michigan Ave., Chicago 1, Illinois

CONSTRUCTION EQUIPMENT

A COMPLETE POWER PACKAGE INCLUDING: Crawler, Wheel, and Pipe-Boom Tractors . . . Self Propelled Scrapers and Bottom-Dumps . . . Crawler and Rubber-Tired Loaders . . . Off-Highway Trucks . . . Diesel and Carbureted Engines . . . Motor Trucks

THOMAS
FLEXIBLE COUPLINGS
Give You Freedom From Coupling Maintenance



NO LUBRICATION

NO MAINTENANCE

NO WEARING PARTS

Future maintenance costs and shutdowns are eliminated when you install Thomas Flexible Couplings. These all-metal couplings are open for inspection while running.

They will protect your equipment and extend the life of your machines.

Properly installed and operated within rated conditions, Thomas Flexible Couplings should last a lifetime.

UNDER LOAD and MISALIGNMENT ONLY THOMAS FLEXIBLE COUPLINGS OFFER ALL THESE ADVANTAGES.

1 Freedom from Backlash Torsional Rigidity
2 Free End Float
3 Smooth Continuous Drive with Constant Rotational Velocity
4 Visual Inspection While in Operation
5 Original Balance for Life
6 No Lubrication
7 No Wearing Parts
8 No Maintenance

Write for Engineering Catalog 51A

THOMAS FLEXIBLE COUPLING CO.
WARREN, PENNSYLVANIA, U.S.A.

2 For active filing in an office area, hanging or vertical units are preferable. Both rate well with respect to accessibility and are marked by low annual cost for filing drawings. Filing cabinets with access from the front are well suited to smaller drawings. The drawings are accessible and protected. The cost per drawing per year is low when small drawings are filed.

3 For inactive filing, those units that can be stacked provide good value. The use of open shelving and closed tubes offers good protection and security at a low annual cost per drawing. The disadvantages of a possible accident hazard with stacked units, and of indexing with shelving units can be more than offset by the savings in cost. Reasonable precautionary measures and improvisations to meet individual conditions can be instituted at reasonable costs and little work.

4 Very long drawings (over 48 in. long) are best filed in files which provide an effective combination of maximum protection, accessibility and reasonable cost.

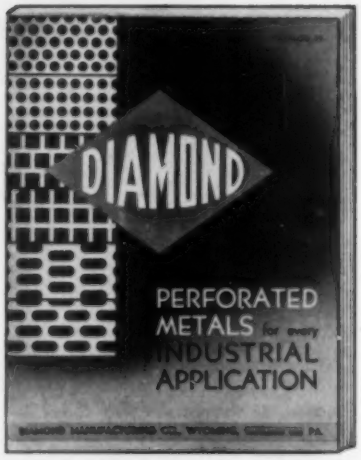
Abstracted from "Standards For Filing Engineering Drawings," by L. Gerber, National Records Management Council, Inc., 555 Fifth Ave., New York 17, N. Y., ASME Paper No. 56-A-93 presented at ASME Annual Meeting, N. Y., Nov. 25-30, 1956.

Stopping Time and Energy Loss of A-C Motors With D-C Braking

The d-c dynamic braking torque speed curve of a-c motors, dependent upon a magnetizing reactance which varies progressively throughout the speed range, is approximated by a discontinuous curve dependent upon the magnetizing reactance values at standstill and top speed only. The former reactance corresponds to full d-c excitation, whilst the latter is the unsaturated value. By this means, the torque speed curve is expressed by a simple mathematical relationship.

The validity of this simplification is investigated by comparison with an accurate method of deducing the curve, published recently by the author, for any degree of magnetic saturation and value of leakage reactance. Good agreement is obtained at all except the largest values of torque,

(Continued on page 402)



This 32-Page Catalog Points the Way to Improved Design of Many Modern Products

Diamond Perforated Metal is an important Factor in the design and construction of more products that enter into every-day life than most people realize.

In Space Heaters, for example, in Air Conditioners, Television Sets, Diffused-Light Fixtures, the Ornamental Enclosures which conceal your radiators, the Spinner Basket of your washing machine, the Screens which help prepare the coal you burn and the food you eat.

Industrial applications cover an even wider range—from Machinery Guards and Sound Control Equipment to Stainless Steel Screens for oil refineries and synthetic rubber plants. New applications are developing every day as we keep in step with the rapid progress of engineers, chemists and industrial designers.

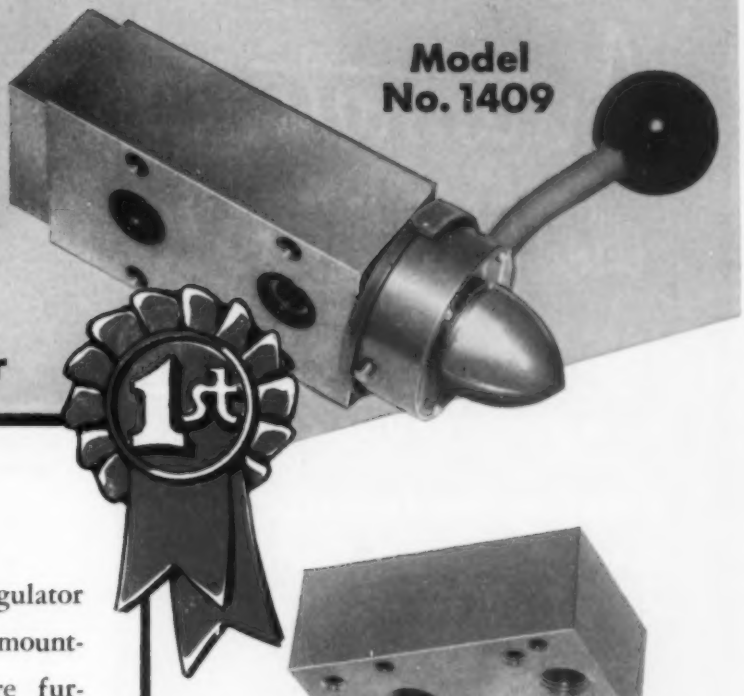
Catalog 39 shows many modern applications; gives all the illustrated working data you need to plan ahead. Write, today, for a free copy and tell us about ANY requirement for Perforated Metal. We are equipped to fabricate complete parts if desired and our engineers welcome opportunities to make money-saving suggestions.

DIAMOND MANUFACTURING CO.
Box 40 WYOMING (Wilkes-Barre Area) PENNA.

West Coast Plant, Diamond Perforated Metals Co. 17915 So. Figueroa St., Gardena, California Los Angeles Area

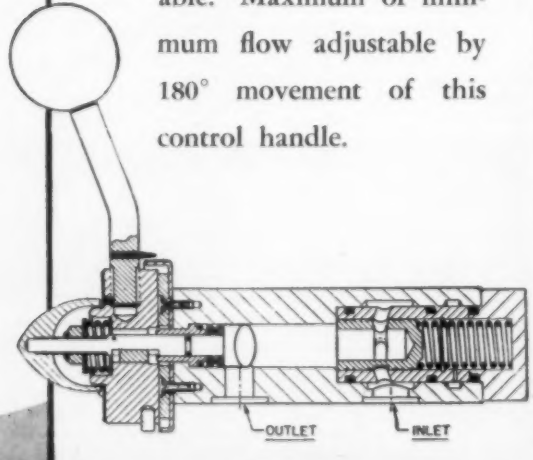
Another WATERMAN WINNER

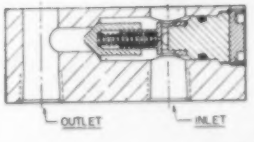
Adjustable Flow Regulator



An adjustable flow regulator adapted for manifold mounting. Sub-plate kits are furnished with built-in check valves for free reverse flow. They are interchangeable, dependable, light-weight and easily installed.

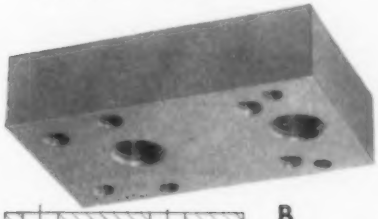
Either right or left hand rotation of control handle is available. Maximum or minimum flow adjustable by 180° movement of this control handle.

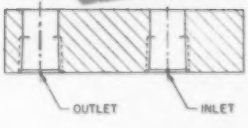




A

110534 Sub-Plate Kit with built-in check valve for free reverse flow.





B

110516 Sub-Plate Kit.

Write for illustrated bulletin E, describing the many valuable features of this Adjustable Flow Regulator.

WATERMAN ENGINEERING COMPANY

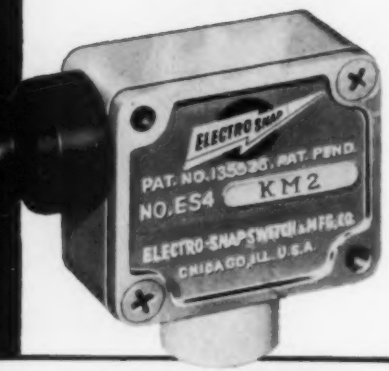
725 CUSTER AVENUE • EVANSTON, ILLINOIS

Automating?

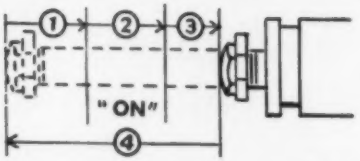
the ONE-WAY IMPULSE SWITCH

for AIR-HYDRAULIC CONTROLS

Eliminates Interlocking Switches and Complicated Actuating Dogs



EXCLUSIVE ACTUATOR LETS YOU DO THINGS YOU NEVER COULD BEFORE

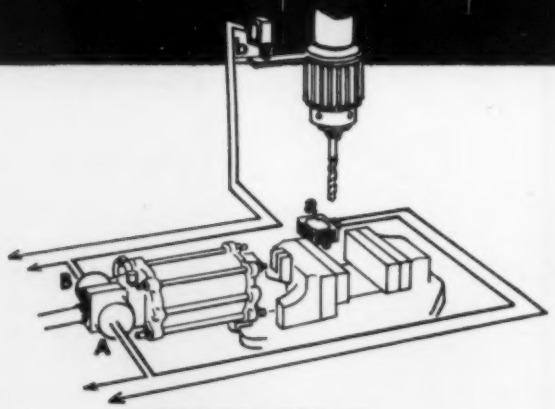


(1) Push the actuator plunger this far and switch completes a circuit.

(2) (On Period)—Circuit remains closed as plunger is pushed through position 2.

(3) (Overtravel)—Circuit is opened and remains open for rest of plunger forward travel.

(4) Switch is *not tripped* on plunger return. Circuit stays open.



SIMPLIFIES CIRCUITS

Only two Electro-Snap Impulse Switches and a double solenoid valve are needed to automatically open and close the air vise on this drill press, for example. Work positioned against Impulse Switch "a" closes vise by pulsing and momentarily energizing solenoid circuit "A". Raising drill after use operates second Impulse Switch "b" to pulse solenoid circuit "B" and open vise. No interlock switches, timers or relays.

MORE DEPENDABLE CONTROL

Troublesome one-way dogs can be eliminated. Special cams and long actuating travel are not required. No delicate adjustments.

LOWER COST, LOWER MAINTENANCE

With Impulse Switches, fewer switches are necessary. Electro-Snap Impulse Switches are $12 to $25 cheaper than timers and other switches which can do the same job. Simplicity of controls makes maintenance easy. You don't need engineers or electronic specialists.

FASTER AUTOMATIC OPERATION

Automatic machines can run faster because cycles can be more closely sequenced. There's no delay due to timer tolerances or extra machine motions to actuate interlock switches.

TRY THIS SIMPLE SWITCH ON YOUR CONTROL JOB $10.50

SEND YOUR STANDARD PURCHASE ORDER

Ask for discounts on quantity purchase

plus $.25 to cover shipping costs

SPECIFICATIONS

Housing—Switch and actuating mechanism enclosed in diecast case. Splash-proof boot protects actuator plunger.

Wire Outlet—Integral conduit boss with standard ½" —14 standard pipe thread.

Mounting—Two No. 8 screws through case.

Capacity—UL rated at 10 amps, 125/250v AC.

Pretravel 0.05".

Movement Differential 0.022".

Operating Force 3½ lbs.

MODEL NO.	Overtravel	On Period (or in. of plunger travel)
ES4-KM1	3/8"	1/16"
ES4-KM2	5/16"	1/8"
ES4-KM3	1/4"	3/16"
ES4-KM6	1/16"	3/8"

ELECTRO SNAP

ELECTRO-SNAP SWITCH AND MFG. COMPANY

4246 WEST LAKE STREET CHICAGO 24, ILLINOIS

Breaking fabrication barriers in new materials with cold forging!

Magnesium, Oxygen-free Copper, Zirconium, High Strength Aluminum Alloys

Most companies and engineering personnel are well acquainted with Hunter Douglas' activities in the field of cold forging aluminum and aluminum alloys. Not so well known are our efforts in the production of magnesium and oxygen-free copper components by the same process. Recently, as the result of a concentrated Hunter Douglas research program, tubular zirconium was successfully cold-forged...an achievement which now opens the door to the fabrication of other rare and costly metals by our cold forging techniques.

The field of cold forging is constantly expanding with many new successes destined for the future.

Where stakes are high and being "first" assures a competitive advantage—in lower cost, better design, greater strength—an original approach to your fabrication problem will pay dividends.

Hunter Douglas cold forging techniques, backed by an unmatched experience in this field, frequently supply the missing key. Many fabrication problems can be solved simultaneously by producing hollow, dense, zero-draft components meeting exact part geometry requirements and difficult performance specifications.

If you have production requirements in any of the metals now being regularly cold forged, we welcome the opportunity of reviewing prints and submitting quotations. Especially important, *if you have an advanced program involving zirconium or other rare metals*, we are in position to devote development facilities to the solution of specific high priority problems.

Among Hunter Douglas' many achievements is the first successful cold forging technique for zirconium ...a metal long believed unresponsive to this process!

By cold forging, the hard surface oxides, carbides and nitrides normally produced by hot working were completely absent, surface finish was good, and in tubular shapes tolerances on diameters and concentricity were held to a few thousandths... far superior to hot extrusions. With almost complete elimination of machining, metal waste was negligible... an extremely important factor with material costs running as high as $20.00 per pound!

Cold forging of oxygen-free copper is now proving important to the electronics industry and experimental development work is in progress on magnesium and even common metals, such as steel. Out of this extensive research program is coming the vital knowledge for meeting tomorrow's unusual problems. Look to Hunter Douglas for everything new in cold forging!

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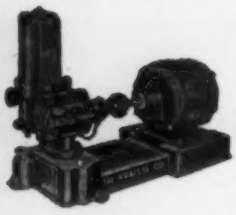

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which occur over a comparatively small speed range. In consequence, the stopping time and total energy loss of the motor, which are dependent upon the integration of the inverse torque throughout the speed range for an inertia load, are readily determined with considerable accuracy by the simplified theory, using derived mathematical relationships. Further, the value of secondary resistance can be readily deduced.

1. The dynamic braking torque vs. speed curve can be represented with reasonable accuracy by a simple mathematical expression, except in the region of maximum torque, for any practical degree of magnetic saturation and value of X_s.

2. The stopping time and energy loss of the motor can be calculated readily, with good accuracy, irrespective of the value of the friction and other torques assisting the dynamic braking torque, provided the sum of the former torques is shown.

3. The secondary resistance which provides minimum stopping time t_{min} can be readily calculated.

4. The optimum value of R_s decreases with increase of saturation.

5. The stopping time attained by changing R_s in one or more successive steps is likely to exceed $0.8t_{min}$, particularly when the friction and other extraneous torques are appreciable compared with braking torque.

6. The energy loss in the primary circuit can exceed considerably that calculated on the assumption that $W_1/W_0 = R_1/R_2$.

Abstracted from "Stopping Time and Energy Loss of A-C Motors With D-C Braking," by O. L. Butler, University of Sheffield, Sheffield, England, presented at AIEE Winter General Meeting, Jan. 21-25, 1957, New York, N. Y.

Diaphragm Characteristics

Characteristics of diaphragms determined by tests are described in a systematic arrangement. The effects of pressure, force and deflection on the force constant, pressure constant, effective area and available energy are illustrated by graphs.

Abstracted from "Diaphragm Characteristics," by Floyd B. Newell, Instrument Engineer, Taylor Instrument Co., Rochester, N. Y., ASME Paper No. 56-A-220, presented at ASME Annual Meeting, N. Y., Nov. 25-30, 1956.

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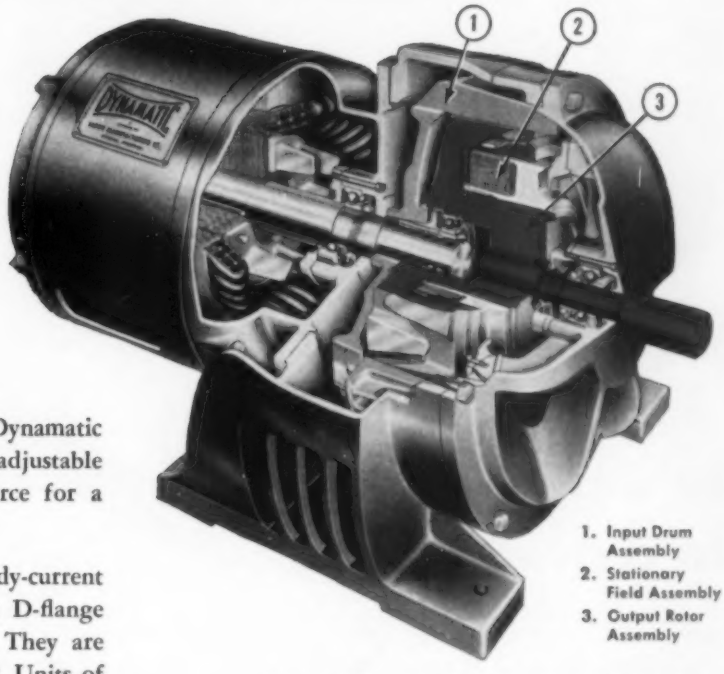

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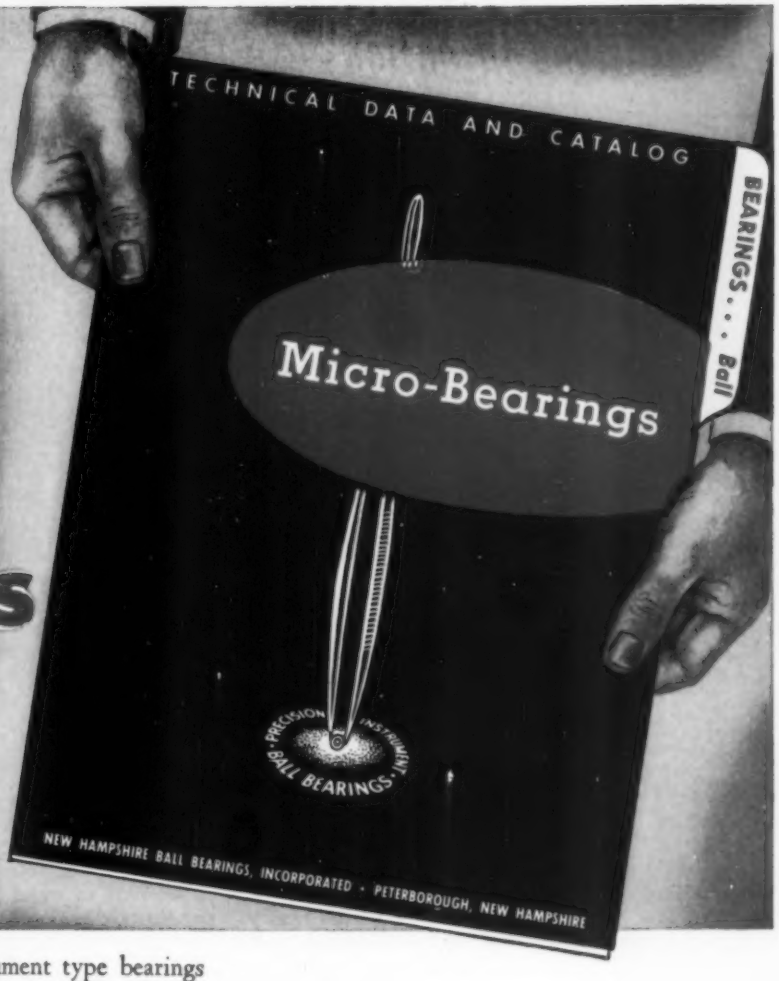
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NEW BOOKS

Patent Notes for Engineers

C. D. Tuska. 6 x 9 *in.*, 171 *pp. Published by McGraw-Hill Book Co., 330 W. 42 St., New York 36, N. Y.* $4.

The seventh edition of this familiar manual is intended to fill the needs of those individuals concerned with patent law yet who are neither laymen nor lawyers. The treatment is not an oversimplification nor does it become so involved as to be incomprehensible to engineers unfamiliar with legal concepts and terminology.

Chapters are devoted to statutory inventions, its nature, and practical aspects. The need for good records and adequate disclosures is stressed in a chapter entitled "Records of Inventions." Further sections cover Prosecution of Patent Applications, Interferences, Patent Approval, and the Ownership and Use of Patents.

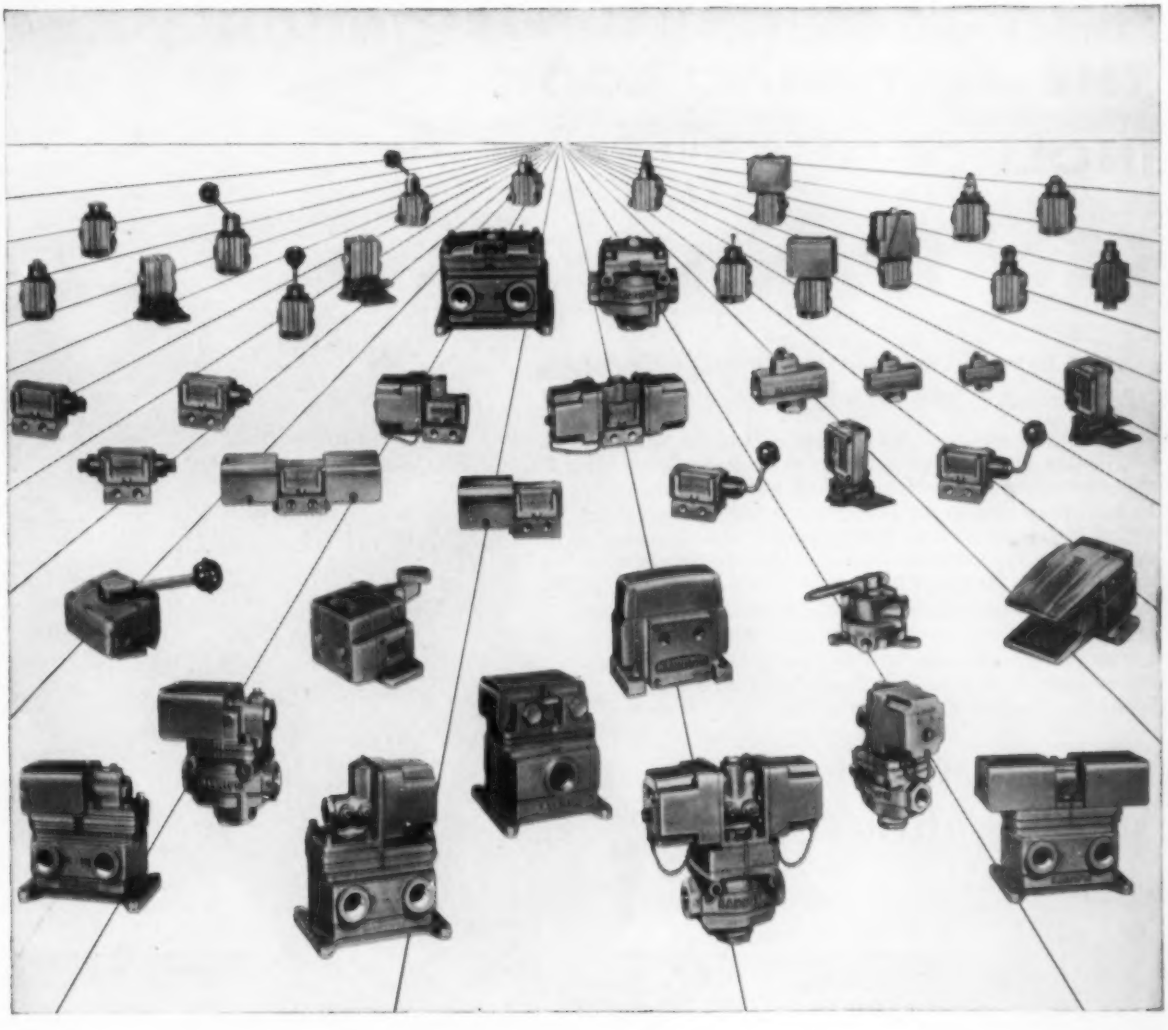
Modern Mathematics For the Engineer

Edwin F. Beckenbach, *Professor of Mathematics, University of California.* 6 x 9½ *in.*, 490 *pp. Published by McGraw-Hill Book Co., 330 W. 42 St., New York 36, N. Y.* $7.50.

This book presents a broad survey of the application of advanced mathematics to today's rapidly expanding technology. This is the second of the contributed text books which grew out of the engineering extension lecture courses at the University of California at Los Angeles. The first book in the series was "Modern Physics for the Engineer."

Emphasis is on the importance of stochastical analysis, the theory of games, operations analysis, and linear, nonlinear, and dynamic programming in modern engineering. The methods and applications of the new high-speed computation procedures is extensively covered. The book is thus divided into three parts. The first, entitled "Mathematical Models," dwells successively on physical prob-

(Continued on page 410)



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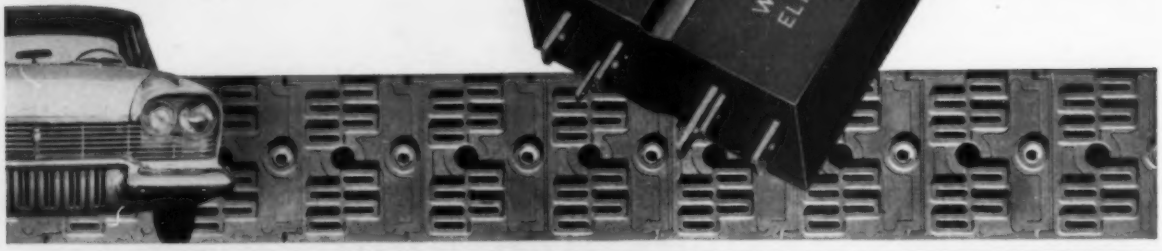

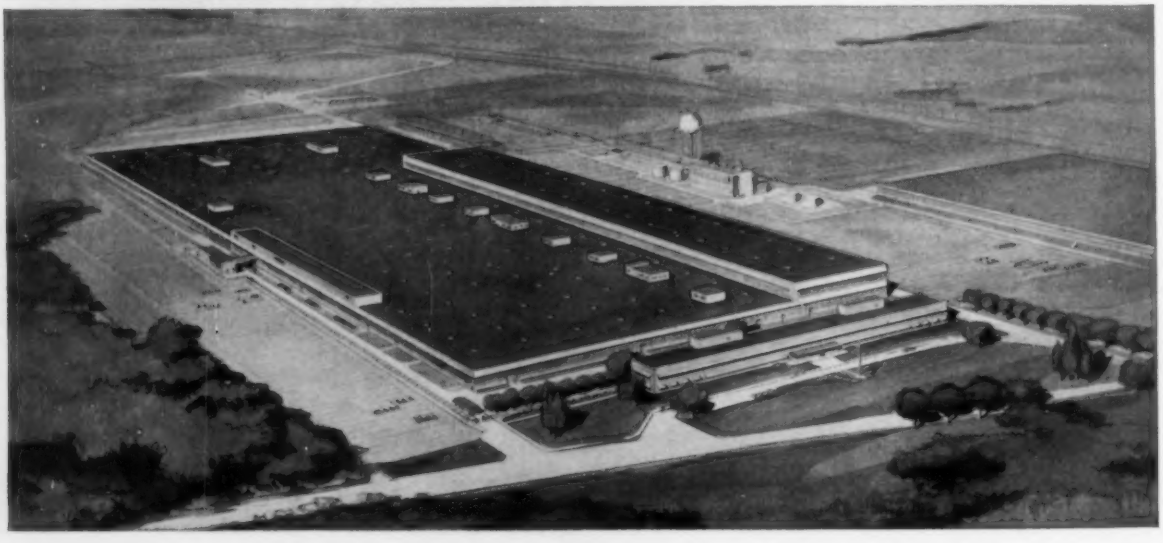

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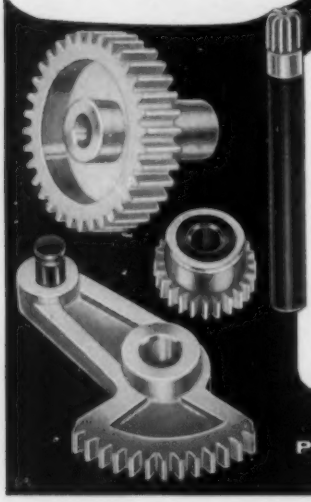

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lems expressed in terms of ordinary differential equations, integral equations, and partial differential equations.

Next, in "Probabilistic Problems" are chapters bearing on the programming and operational aspects of engineering and on the use of probabilistic methods in solving problems. Finally, in "Computational Considerations" the emphasis is frankly on numerical solutions; as in "Modern Physics for the Engineer," the concluding chapter deals with aspects of high-speed computing devices.

This text contains articles by Royal Weller, Solomon Lofschetz, Richard Bellman, John W. Green, Magnus R. Hestenes, Richard Courant, Menahem M. Schieffer, Ivan S. Sokolnikoff, Norbert Wiener, H. Frederic Bohenenblust, Gilbert W. King, George W. Brown, Louis A. Pipes, John L. Barnes, Edwin Beckenbach, Charles B. Morrey, Jr., George E. Forsythe, Charles B. Tompkins, and Derrick H. Lehmer.

Nickel Handbook and Commercial Outlook for 1957

Paper bound, 8½ x 11 in., 70 pp. Available from Herman B. Director Associates, 1511 K Street, N. W., Washington 5, D. C. $10.

Compiled by a group of industrial materials consultants, this report includes a detailed description of the supply-demand outlook for 1957 as well as information on nickel production, consumption, prices, primary producers, plating concerns, jobbers and nickel suppliers. Also covered are government priorities and export regulations.

Analysis of Deformation Volume III—Fluidity

KEITH SWAINGER, *5½ x 8½ in., 239 pp. Published by Chapman & Hall Ltd., 37 Essex St., London, W. C. 2; available from Macmillan Co., 60 Fifth Ave., N. Y. 11, N. Y. $13.*

All substances deform under applied loads. This phenomenon is analyzed by imposing certain restrictions to bring such a wide subject within the scope of one set of mathematically linear equations. Vol. III

(Continued on page 414)

STAINLESS STEEL MAKES THE DIFFERENCE

...its effect on modern appliance design

Make it more attractive – longer-lasting – easier to keep clean. And keep it simple to make. More and more designers "build in" such powerful selling points with stainless steel.

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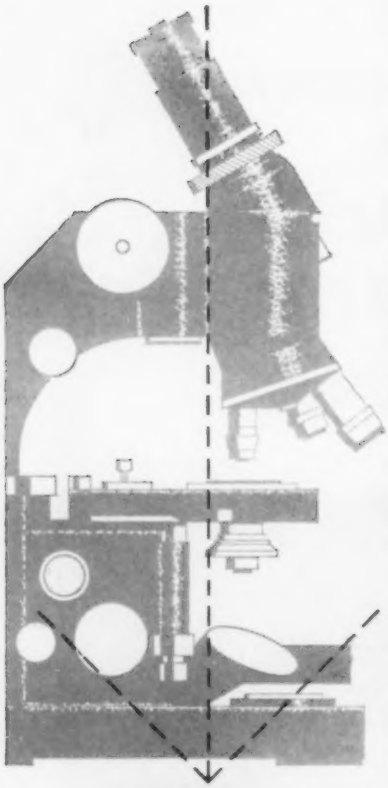
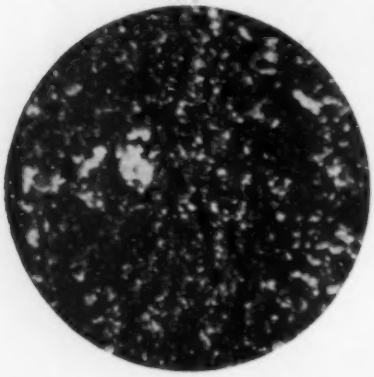
how injection molding can help you solve design problems and improve products that require rubber parts . . .



Modern injection molded rubber.



Standard compression molding.

Greater density produced by injection molding of rubber is shown in comparison to ordinary compression molding. Injection molded rubber (top) displays homogeneous characteristics unequalled for consistency or toughness by any other process. In application, this will mean tremendous resistance to abrasion and chemical action—much longer life for rubber parts. Both microphotographs are standard Buna N compound, approx. .269″ x .019″, magnified 240 diameters by the University of Minnesota.

The unequalled high density that results from *injection molding* of organic, synthetic, and silicone rubber compounds offers the key to optimum performance from rubber parts. Minnesota Rubber and Gasket Company uses an exclusive injection molding process that provides matchless product consistency and tolerances as close as .002 inch, all on a mass production scale. Custom compounding and laboratory facilities for research, problem analysis and product development are among the many additional services offered you.

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3. *Sub-miniature* . . . gaskets with round cross sections as small as .020 inch are but one of many minute parts produced by Minnesota Rubber. Sub-miniature fabrication is carried on in a variety of compounds including, Neoprene, Buna N, and various silicone rubbers.
4. *Seals* . . . O-ring seals are produced and stocked by Minnesota Rubber in a complete range of standard sizes. Special sealing problems also receive immediate attention and solution. Also available is the revolutionary QUAD® RING , an exclusive development of Minnesota Rubber.

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Lower costs both in product development and production will be yours because of Minnesota Rubber's complete facilities and mass production techniques. Injection molding not only permits greater economy through higher efficiency, but it eliminates many secondary finishing steps required by other molding processes. In addition, the most modern production systems and new plant facilities assure you of fast production, quick delivery—no expediting costs.

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Statistical sampling and laboratory analysis during every phase of production assures you of the finest quality in finished parts. This means extra savings in rejects and replacement costs . . . greater dependability, longer part life.

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Progress Report:

SCHRADER AIR PRODUCTS CAN MAKE PRECISION OPERATIONS EFFICIENT

● Let's clear the air about close tolerances

We've faced it. Lots of manufacturers still think air is as unpredictable as the weather report. But others know better, because they've taken the time to let a little sunlight on the subject. These open-minded ones are utilizing Schrader Air Products, not just to hold work or blow away chips, but to produce complex units to close tolerances.

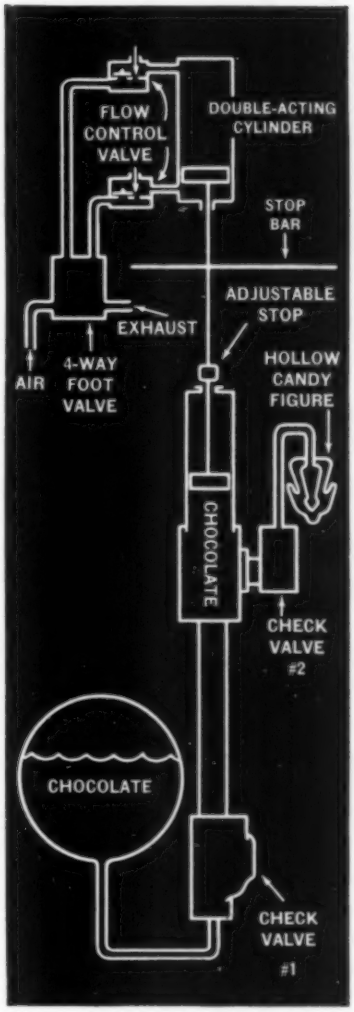
Air is a big boy now. It has grown up fast because automation came because pennies needed pinching. Because many operations in manufacturing turned out to be just plain dangerous. Then engineers found air was not only efficient, economical, and safe, but that products were already designed and produced to make air a logical way of performing hundreds of special jobs.

FOR EXAMPLE:

● Sweet words about air from a candy maker

At a Buffalo, New York, candy company, Schrader Air Products have been used to perform a complex measuring operation. To within one gram! Six Schrader double-acting cylinders are used to fill a bank of six more single-acting cylinders with a prescribed amount of chocolate. When a foot valve is released, the chocolate is forced into wax figurines, exactly filling them. And the entire installation is even covered and kept at a constant temperature to insure the proper chocolate viscosity.

Take a look at the schematic. It shows the arrangement by which the Schrader Air Products are adapted to an operation which might at first seem far outside the limits of air use. It was possible because some engineers put on their thinking caps.



Schematic shows how Schrader Air Products are adapted for precision handling of liquid chocolate.

● Talk about air's advantages being automatic—lend an ear

This is important to you, so don't wander off. When air is used to synchronize motions automatically, efficiency is almost sure to follow. BUT, the natural advantages of air multiply like rabbits. For instance, economy is basic. In many cases it can make the difference between profit and loss. Then, safety margins are widened by the use of special control techniques. Air's simplicity makes possible easy finger-tip and tip-toe operation of tiring hand and foot movements. Fatigue? Who's tired? Production goes up. Modern packaged control sets are so highly developed that most hazards of press operation are no longer applicable. Both hands must be used at once, and cannot stray into danger zones. Any machine using a mechanical clutch, shears, brakes and friction clutches can use special controls.

● We <u>like</u> to be taken advantage of

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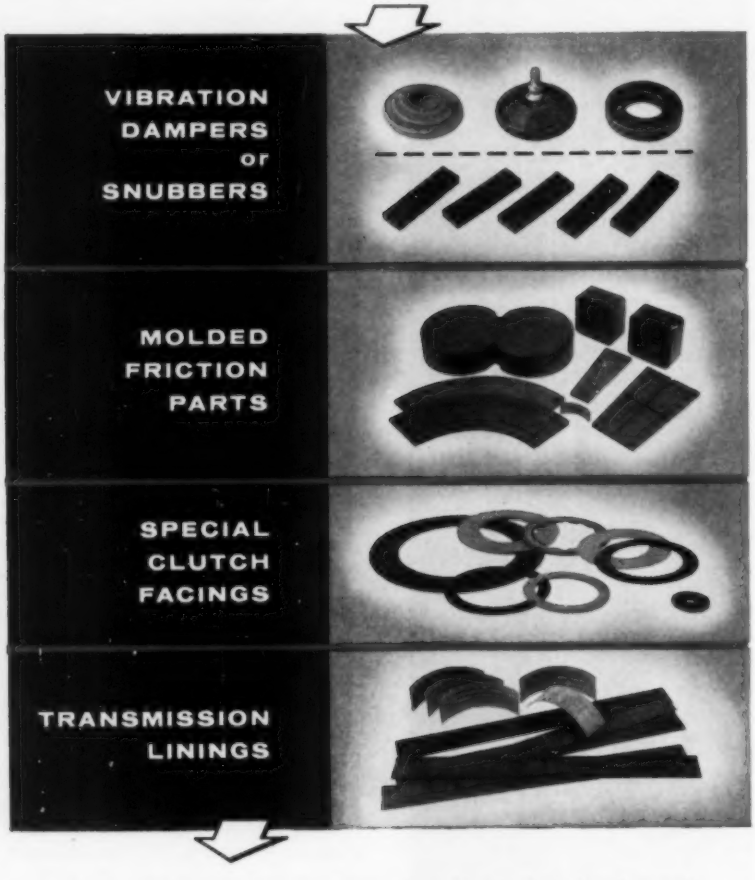

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of this series focuses attention on the fluidity aspects of the deformation problem.

An explicit, critical examination of the classical approach to fluid mechanics is made and the author shows that the non-linear convective acceleration term of Euler (1755) should not appear in the motion stress equation and so removes a major obstacle to progress in fluid mechanics. Bernoulli's theorem (1738) is seen to fail in several examples. The reason is inherent in the classical approach to fluid mechanics, having overlooked the formulation of compatibility conditions for the time-rates of change of strain in the fluid.

Mathematics used in the development of the theories are of an advanced nature, requiring at least a knowledge of vector analysis.

Chromium, Vol. II

ACS Monograph No. 132. Edited by MARVIN J. UDY. *6½ x 9 in., 402 pp. Published by Reinhold Publishing Corp., 430 Park Ave., New York 22, N. Y. $11.*

Volume II of this series is, perhaps, of more interest to the design engineer. Volume I covered the "Chemistry of Chromium and Iits Compounds"; Volume II discusses "Metallurgy of Chromium and Its Alloys." Covered are: recovery from ores, electrowinning of chromium, deposition of chromium, metallurgical uses, and chromium in refractories. A complete and useful bibliography is appended to each of the chapters.

Bearing Technology for The Designer

PB 121366, K. KOLLMAN *and H.* HAHN, *Karlsruhe, Germany. 10½ x 8 in., paper-bound, 26 pp. Published by U. S. Dept. of Commerce, Office of Technical Services, Washington 25, D. C. $0.75.*

This volume contains papers presented at a convention of the Stuttgart unit of the Study Group of Design Engineers held in Oct. 1954 to acquaint industrial designers with results of the latest research in roller and friction bearing technology. Included are reports of research on roller

(Continued on page 419)

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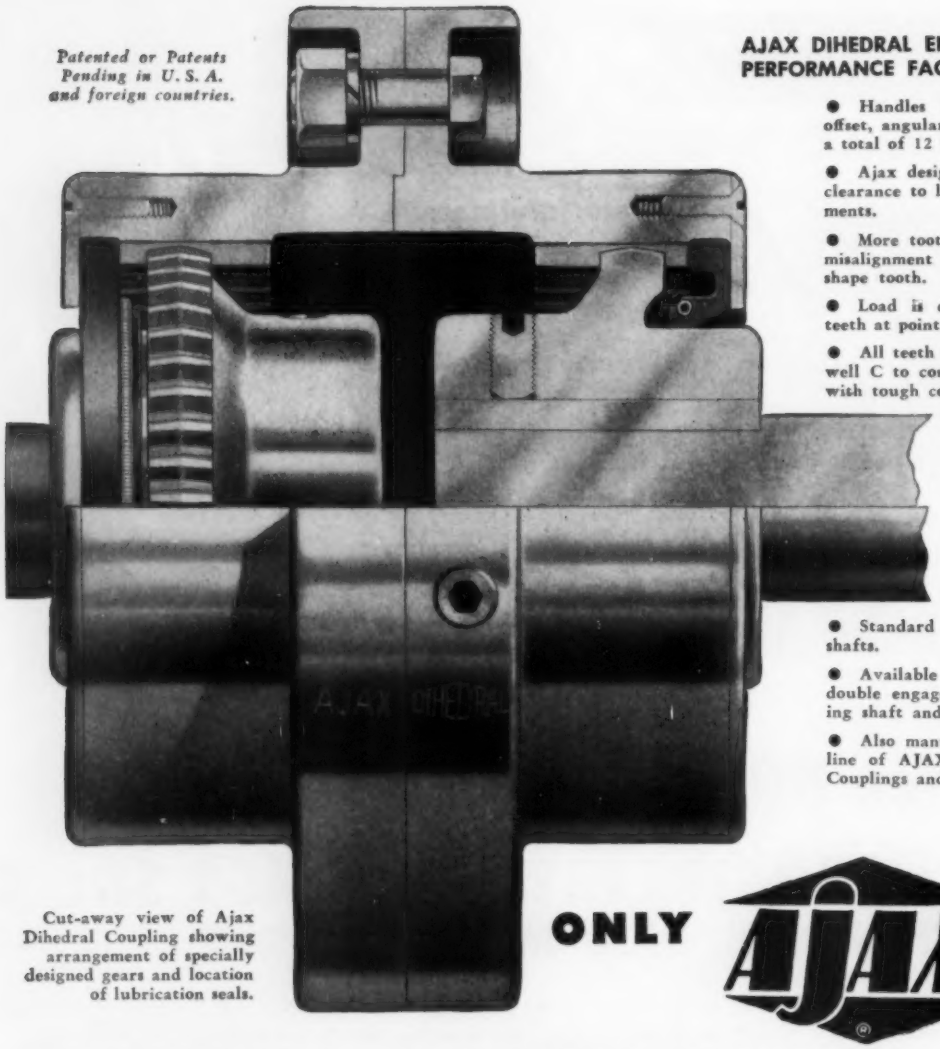

Cut-away view of Ajax Dihedral Coupling showing arrangement of specially designed gears and location of lubrication seals.

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- Handles shaft misalignment, — offset, angular and end float — up to a total of 12 degrees.
- Ajax design permits holding tooth clearance to lubrication space requirements.
- More tooth area in contact under misalignment than with any other shape tooth.
- Load is distributed at center of teeth at point of greatest strength.
- All teeth hardened to 50-55 Rockwell C to combine hard wear surface with tough core.
- Seals keep lubricant in and dirt out.
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- Free end float.
- Standard sizes to fit ½" to 11" shafts.
- Available in regular single and double engagement, mill motor, floating shaft and spindle shaft types.
- Also manufacturers of a complete line of AJAX Rubber-Bronze Bushed Couplings and Vibrating Conveyors.

ONLY AJAX

DIHEDRAL COUPLINGS PUBLISH THEIR MISALIGNMENT CAPACITIES

MAXIMUM PARALLEL-OFFSET CAPACITY FOR COUPLINGS DESIGNED TO ACCOMMODATE ANGULAR MISALIGNMENT AS SHOWN IN TABLE*

Coupling Size	Distance Between Center Lines of Hub Gears	ANGULAR MISALIGNMENT CAPACITY OF COUPLING 4°	7°	12°
150	2⅜"	.092	.160	.263
200	3 3/16"	.116	.202	.335
250	3¾"	.131	.229	.380
300	4½"	.157	.275	.452
350	5 1/16"	.177	.309	.498
400	5 9/16"	.194	.339	.551
450	6⅛"	.214	.374	.604
500	6¾"	.236	.412	.651
550	7⅞"	.275	.480	.781
600	9"	.314	.549	.899
700	10 1/16"	.351	.614	1.004

* For double engagement Dihedral Couplings only. Angular capacity is reduced to zero (0) when full parallel-offset condition exists.

Ajax misalignment capacities are cataloged so that engineers can design misalignment into as well as out of the machines they build. Ajax Dihedral Couplings make possible design improvements based on ability to handle misalignment heretofore impossible with conventional couplings.

In addition, they are providing constant angular velocity which results in better performance, better product quality and greatly increased output speeds under severest conditions of heavy loads and high horse powers.

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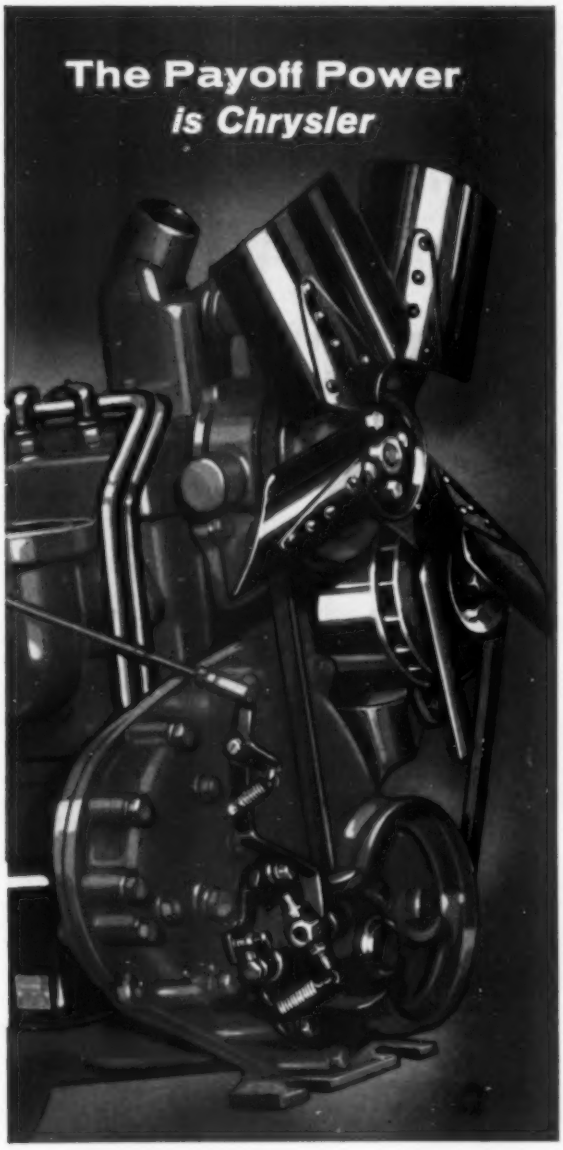

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Chrysler Industrial Engine Specification Booklet. Includes engine specification, performance data, power curves for all models. Write Dept. **B-3,** Industrial Engine Division, Chrysler Corporation, Detroit 31, Michigan.

SPECIFICATIONS — CHRYSLER INDUSTRIAL ENGINES

	Ind. 30	Ind. 31	Ind. 32	Ind. 33	Ind. 52	Ind. 56-A
No. of Cylinders	6	6	6	6	8	8
Type of Engine—4 Cycle	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline
Bore—Inches	3¼	3¼	3⅞	3⅞	3⅞	3.94
Stroke—Inches	4⅛	4⅛	4¼	4¼	3¼	3.63
Displacement—Cu. In.	230	230	265	265	270	354
Compression Ratio	7.0	7.0	6.8	6.8	7.5	7.6
Valves—Arrangement	L	L	L	L	OHV	OHV
Camshaft Drive	Silent Chain	Gear	Silent Chain	Gear	Silent Chain	Silent Chain
Engine Width*	23 1/16"	23 1/16"	23 1/16"	23 1/16"	30 7/16"	28 13/16"
Engine Length*	32 7/16"	31 13/32"	32 19/32"	33 11/16"	29 21/32"	31 3/32"
Engine Height*	34½"	32 27/32"	32 29/32"	32 29/32"	34¾"	34 23/32"
Engine Weight*	575 lbs. (approx.)	610 lbs. (approx.)	740 lbs. (approx.)	760 lbs. (approx.)	712 lbs. (approx.)	845 lbs. (approx.)

*Dimensions vary with equipment.

Specifications subject to change without notice.

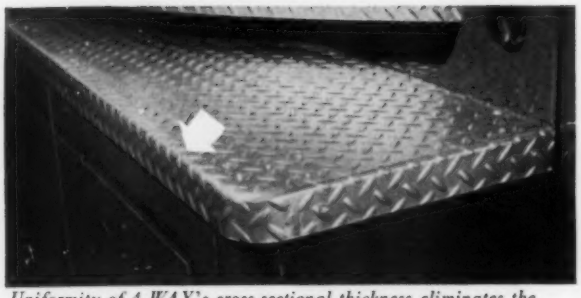
Chrysler

INDUSTRIAL ENGINES

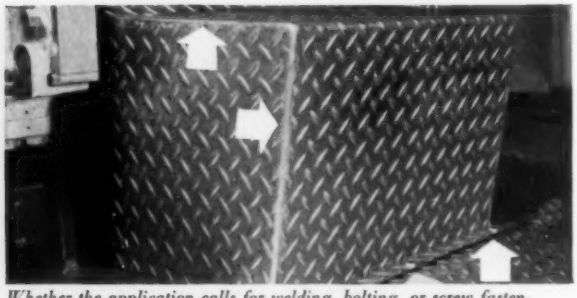
INDUSTRIAL ENGINE DIVISION • CHRYSLER CORPORATION

tough fabricating job on fire engine proves 4-WAY'S® versatility

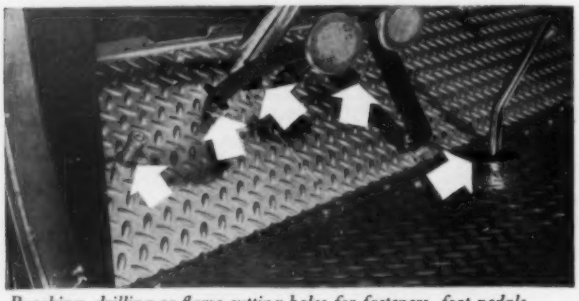
Fabrication to form even the varied and complex shapes used on firefighting equipment is no problem with 4-WAY Safety Plates. No special tooling is necessary. Ordinary cutting, drilling, forming and similar standard shop equipment is all that's needed. Good reason why this leading chassis and body manufacturer has specified Inland 4-WAY for more than 15 years! 4-WAY is used in an uncommonly wide variety of ordinary and extraordinary applications. For complete information and specifications, write Dick Prendergast, Room 1262 at the address below.



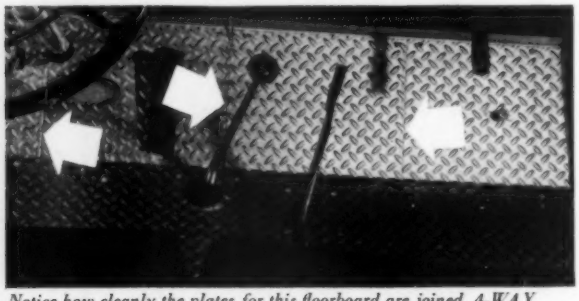
Uniformity of 4-WAY's cross-sectional thickness eliminates the possibility of deflection while bending, even at sharpest angles. Standard equipment can be used.



Whether the application calls for welding, bolting, or screw fastening, all are easily accomplished on 4-WAY with conventional methods.



Punching, drilling or flame cutting holes for fasteners, foot pedals, etc. is no problem with 4-WAY.



Notice how cleanly the plates for this floorboard are joined. 4-WAY can be sheared to extremely close tolerances eliminating all guesswork and make-overs.

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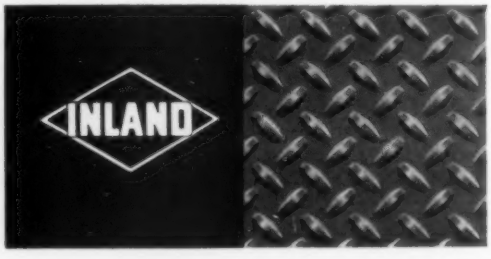

bearings entitled "Bearing Capacity and Life Duration of Roller Bearings"; "Design Problems in Designing of Recent Roller Bearing Systems"; and "Friction and Lubrication of Roller Bearings." Those on friction bearing technology are "Newer Viewpoint of the Phenomenon of Lubrication"; "Phenomenon of Mixed Friction and Its Effect on the Boundary Loading of a Friction Bearing"; "Calculation of the Temperature of Friction Bearings"; and "Highly Loaded Friction Bearings."

A Metallurgical Study Of Molybdenum

PB 111753, S. L. Case, Battelle Memorial Institute, for Office of Naval Research. Available from U. S. Dept. of Commerce, Office of Technical Services, Washington 25, D. C. $2.75.

This report summarizes the results of a five-year study between 1949 and 1954, and contains an appraisal of the data obtained and their significance as applied to three major phases of the investigation: (1) room-temperature ductility, particularly in weldments; (2) high-temperature properties of molybdenum and its alloys; and (3) oxidation-resistant coatings. Report is primarily interpretive in nature, and cites progress reports in which more detailed data may be found.

Mechanics for Engineers—Statics

Ferdinand P. Beer, *Professor of Mechanics, and* E. Russell Johnston, Jr., *Lehigh University.* 6 x 9 *in.*, 350 *pp. Published by McGraw-Hill Book Co., 330 W. 42 St., New York 36, N. Y.*

Mechanics may be defined as that science which describes and predicts the conditions of rest or motion of bodies under the action of forces. It is divided into three parts: mechanics of rigid bodies, mechanics of deformable bodies and mechanics of fluids.

The mechanics of rigid bodies is subdivided into statics and dynamics, the former dealing with bodies at rest, the latter with bodies in motion. One of the characteristics of the approach used in these volumes is that

(Continued on page 422)

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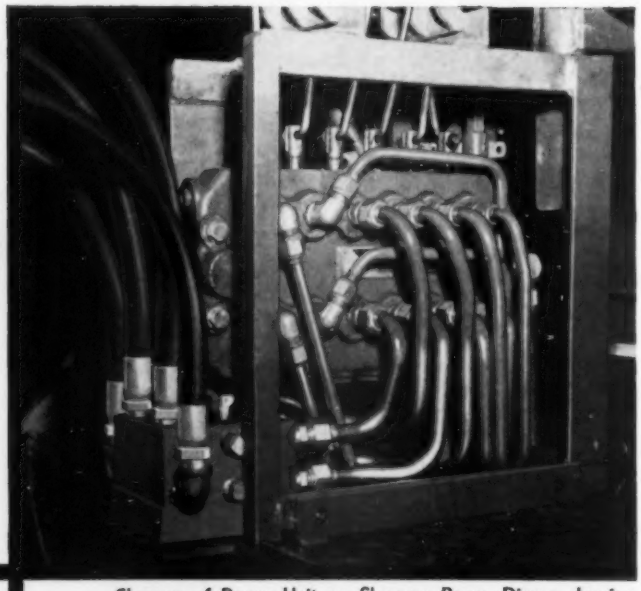
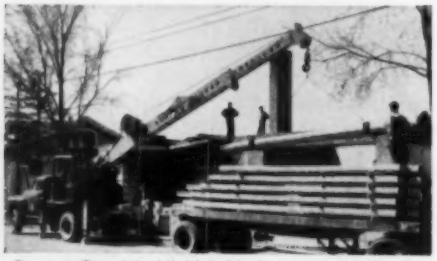


Close-up of Power Unit on Sherman Power Digger showing direct power delivery from *lever to load*. Pilot model equipped with Eastman Hydraulic Hose and Tube Assemblies.

International Harvester Model 75 Payscraper. First application of hydraulic steering on earth movers. USER OF EASTMAN EQUIPMENT.

Allis-Chalmers Model 100 ALL CROP Harvester. Steering brakes and header height hydraulically operated. USER OF EASTMAN EQUIPMENT.



Bucyrus-Erie Model H-5 Hydrocrane. Hydraulically controlled boom, out riggers and bucket. USER OF EASTMAN EQUIPMENT.

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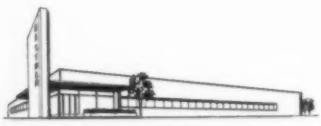
It pays to write Eastman ***FIRST*** *... because Eastman was first in the field of Hydraulic Hose Assemblies*



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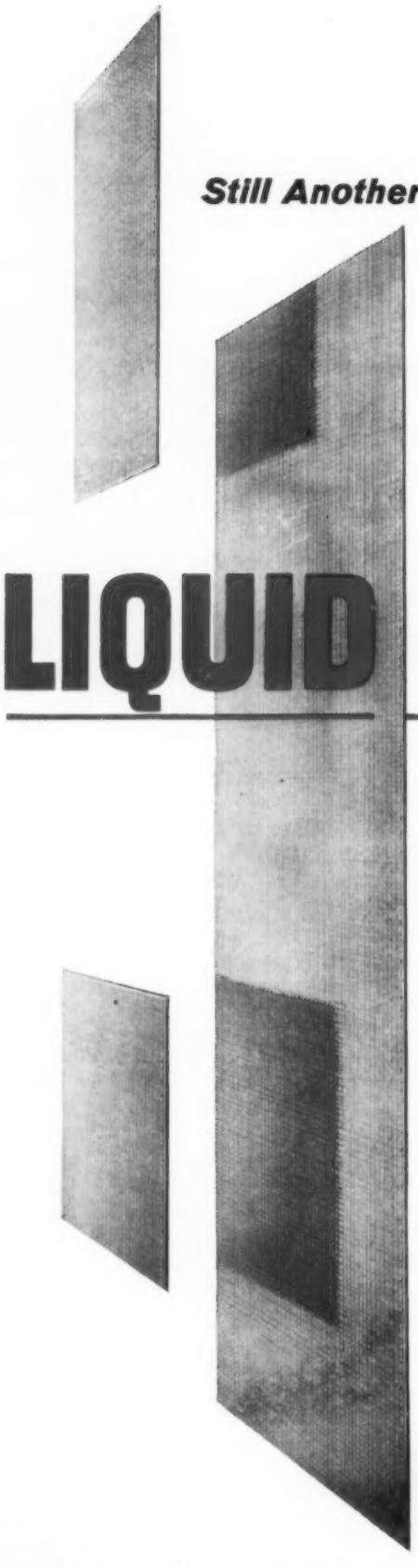

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the mechanics of particles has been clearly separated from the mechanics of rigid bodies. This approach makes it possible to consider simple practical applications at an early stage and to postpone the introduction of more difficult concepts. For example, the statics of particles is treated first (Chapter 2), and the principle of equilibrium is immediately applied to practical situations involving only concurrent forces. The statics of rigid bodies is considered in Chapters 3 and 4, where the principle of transmissibility and the associated concept of moment of a force are introduced. In the volume on dynamics, the same division is observed. The basic concepts of force, mass, and acceleration, of work and energy, and of impulse and momentum are introduced and first applied to problems involving only particles. Thus the reader may familiarize himself with the three basic methods used in dynamics and learn their respective advantages before facing the difficulties associated with the motion of rigid bodies.

Glossary of Rubber and Rubber-Like Materials

6 x 9 *in.*, 121 *pp.*, *paper-bound, published by ASTM,* 1916 *Race St., Philadelphia* 3, *Pa.* $3.

This glossary contains over 2,000 terms. An appendix contains trade names of apparatus and chemicals (whose compositions have been published) related to the field of rubber. This volume was compiled under the auspices of ASTM Committee D-11 on Rubber and Rubber-Like Materials.

Materials and Processes In Manufacturing

E. Paul Degarmo, *M.S.* 6 x 9 *in.*, 755 *pp.*, *Published by Macmillan Co. 60 Fifth Ave., New York* 11, *N. Y.* $8.50.

This book is intended primarily as a college-level text for engineering students. Therefore the subject matter in this book is presented from the viewpoint of manufacturing. For example, the material on metallurgy is not presented from the viewpoint of the metallurgist. Rather it is metal-

(Continued on page 427)

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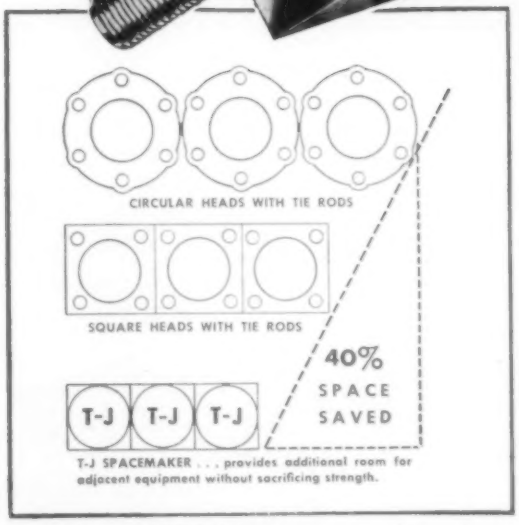
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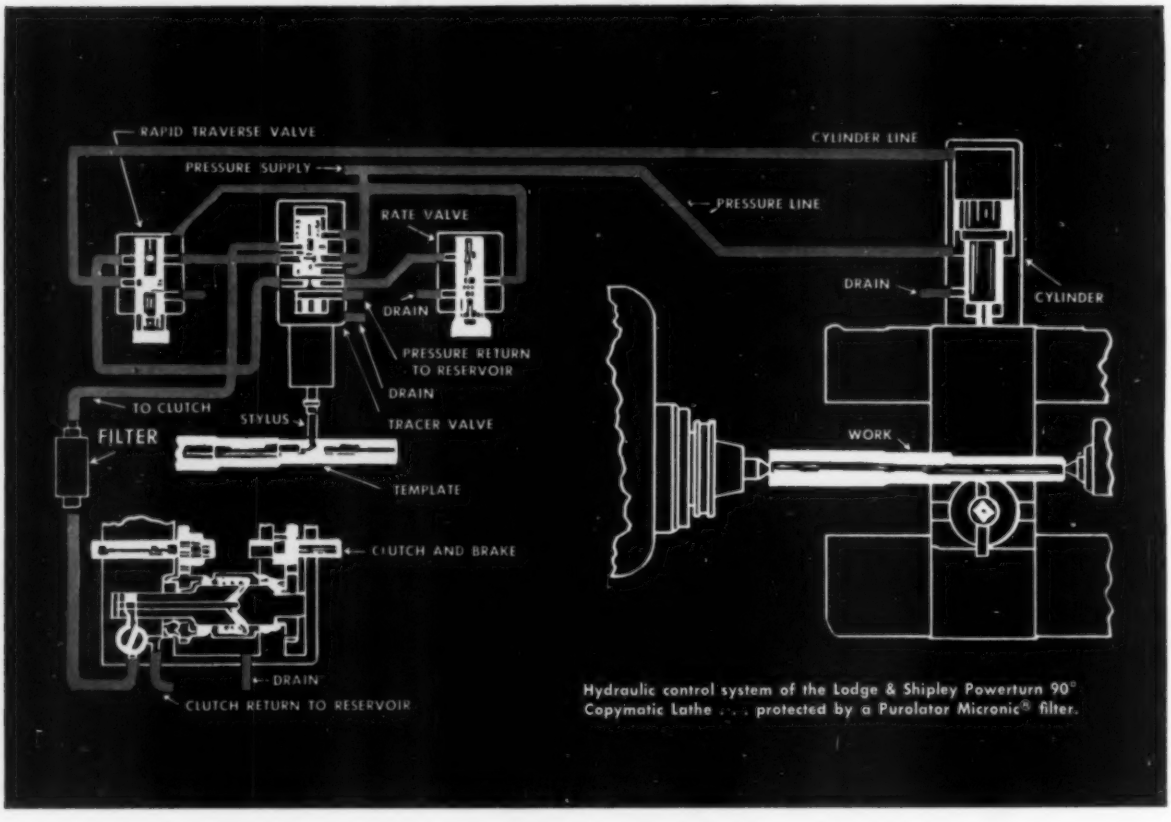

Hydraulic control system of the Lodge & Shipley Powerturn 90° Copymatic Lathe . . . protected by a Purolator Micronic® filter.

Designed for highly accurate control ...fully protected by Purolator Filtration

On a very successful automatic duplicating lathe, this hydraulic control system makes possible both quick, simple operation and a high degree of sensitivity and accuracy. Reliable and uninterrupted operation of a system like this is dependent upon freedom from contaminants. That's why the Lodge and Shipley Company, its manufacturer, made Purolator Micronic® filters an integral part of their hydraulic system.

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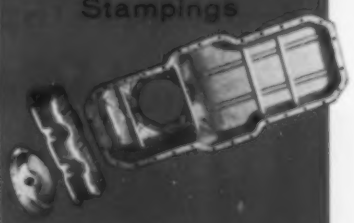

Stampings for heavy trucks successfully produced by the wide range of Transue press equipment. Assembly operations completed by T & W include the sump ring, gasket flange reinforcements, and baffles, riveted and welded in place.

Off-the-highway truck axle, weighing 400 lbs., forged from G-1030 steel, delivered to truck builder heat-treated and cleaned, ready for machining and final assembly.

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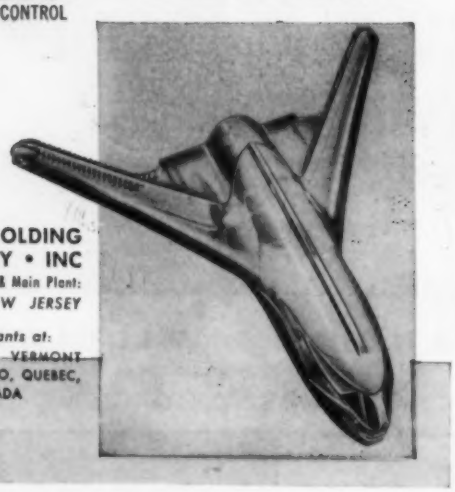

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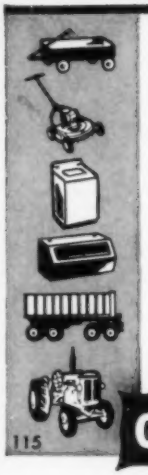

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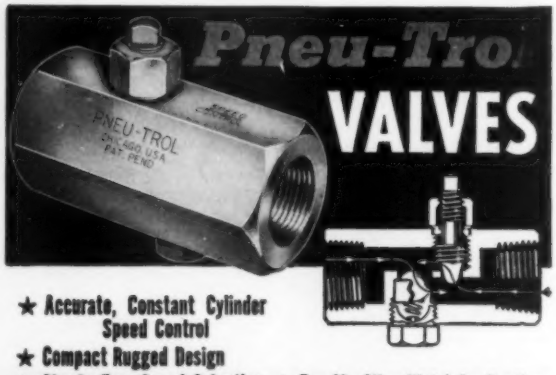

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lurgy as needed to explain how and why a given material is used for a certain manufacturing application, why it must be handled in a certain manner, and why it reacts as it does when processed. Similarly, with respect to machine tools the emphasis is upon what they will do, how they do it, their accuracy, and their relative advantages and limitations—particularly economic. While some attention must be given to details regarding their construction and operation, this is solely for the purpose of providing a better understanding of the relationship of the tools to the foregoing objectives.

Instruction in materials and processes usually is provided in one of two ways. One uses an integrated course which covers both subjects; the other utilizes one course in introductory metallurgy and a second course in manufacturing processes. This text has been organized to meet the needs of both plans.

Some of the section headings: materials, casting and forming processes, machining processes, welding and allied processes.

Supplement to Non-Ferrous Standards

1956 Supplement to ASTM Standards, Part 2, Non-Ferrous Metals. 9 x 6 in., paper bound, 360 pp. Available from ASTM, 1916 Race St., Philadelphia, Pa. $4.

Supplement includes 60 standards covering copper and copper-base alloys; nickel and nickel-base alloys; electrical resistance and related alloys; metal powders and products; die cast metals and alloys; aluminum and aluminum alloys; magnesium and magnesium base alloys; and metallic electrical conductors.

The Diecasting Process

H. K. Barton. 9 x 6 in., 224 pp. Published by Macmillan Co., 60 Fifth Ave., New York 11, N. Y. $5.

For the first time, there has been gathered in one authoritative book all the more important information on diecasting which was previously scattered in a variety of publications. Of

(Continued on page 430)

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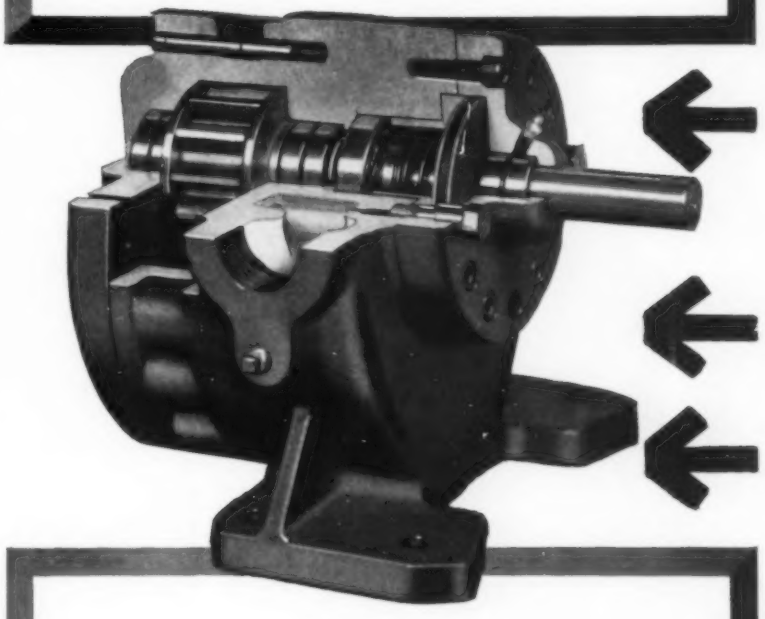

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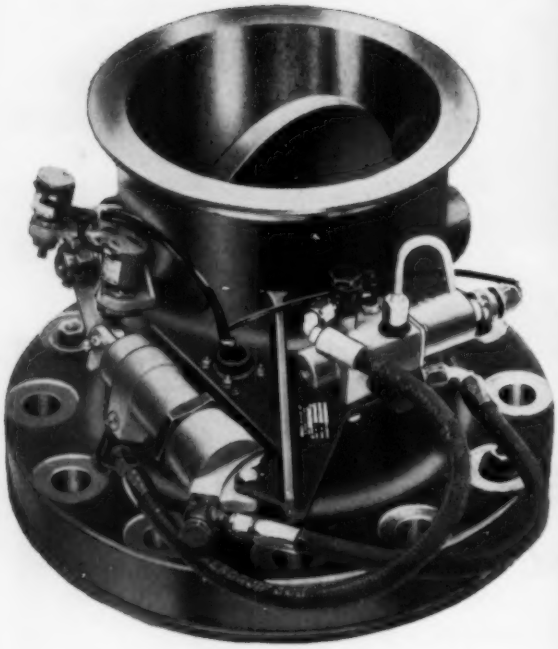

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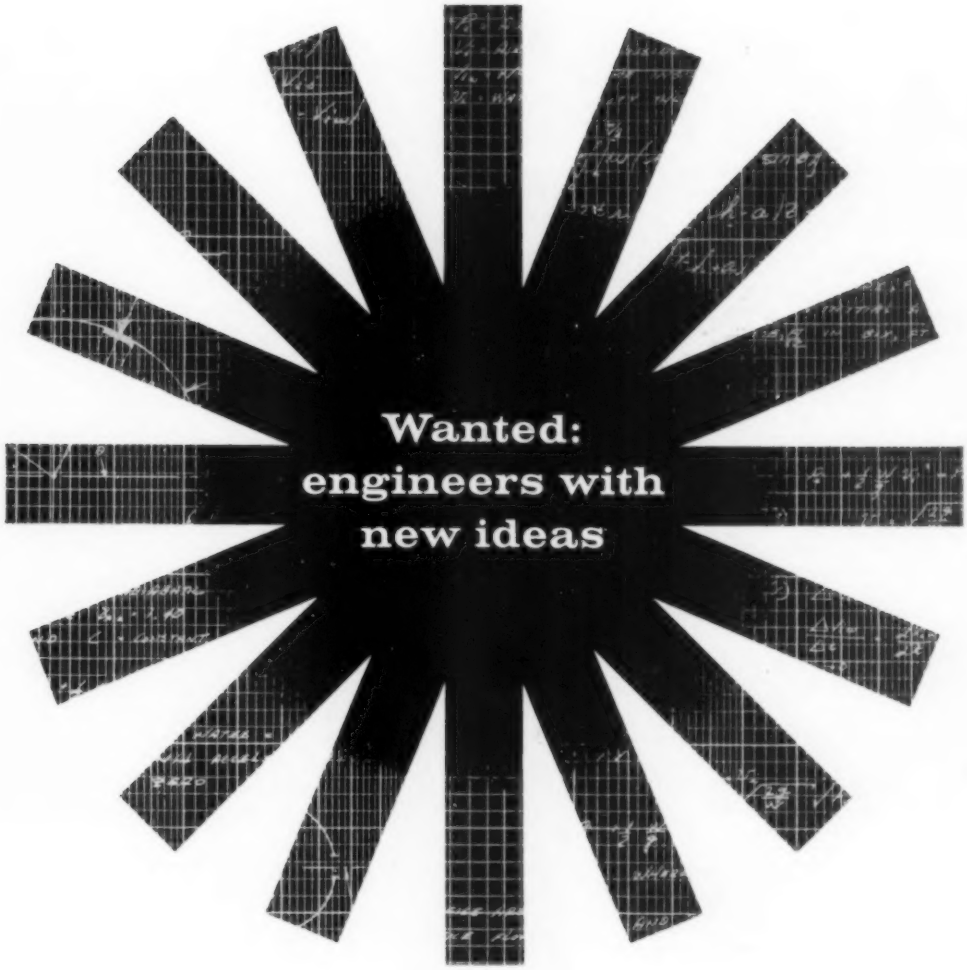

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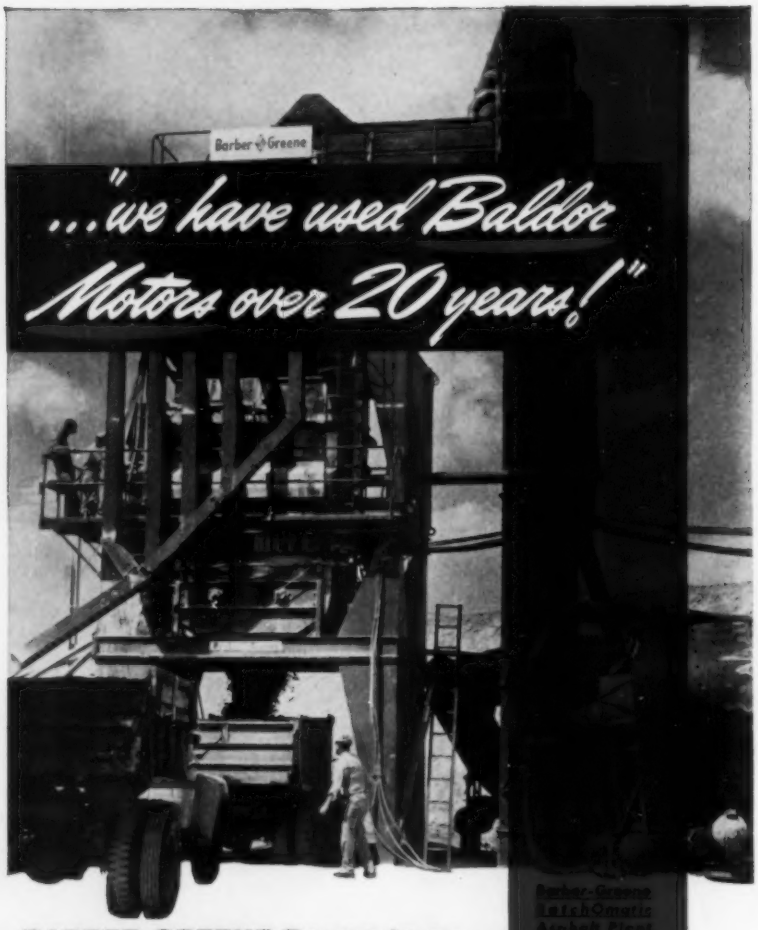

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special interest to design engineers are the sections of the book which deal in detail with what can and cannot be obtained by standard diecasting techniques. Possibilities, advantages and limitations of the process are discussed impartially in the light of the latest information.

A number of appendices give special but related information covering diecasting alloys, machining recommendations, polishing and plating of diecastings. An index is included.

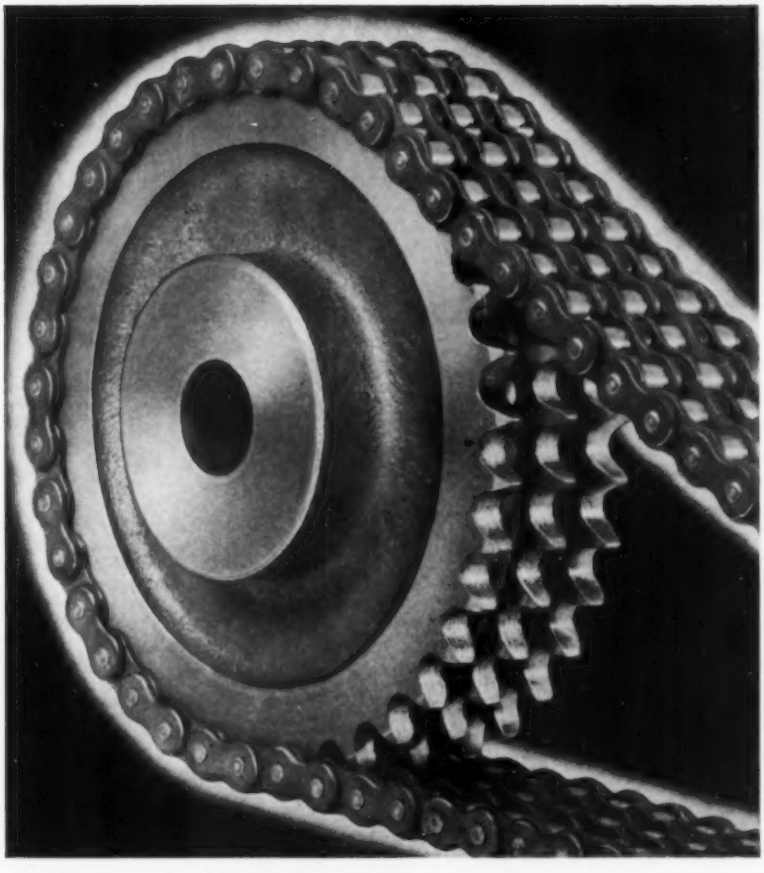
Engineering Uses of Rubber

Edited by A. T. McPherson, *Bureau of Standards and* A. Klemin, *Consulting Engineer.* 9¼ x 6¼ *in.*, 490 *pp. Published by Reinhold Publishing Corp.*, 430 *Park Ave., New York 22, N. Y.* $12.50.

This book is based on the author's experience with aircraft design. Confronted by a lack of readily available information on rubber, he outlined a volume for the designer outside the rubber industry. After his passing, Dr. McPherson, Associate Director of the Bureau, completed the task of obtaining, collating and editing chapters from 19 experts in the field.

The book covers four major areas of interest to the designer: manufacture of rubber goods, properties and behavior of rubber, applications, and means of obtaining rubber products. There is a chapter on "Specification and Inspection of Rubber Products".

A final chapter discusses the relationship between rubber and flexible polymers being developed.



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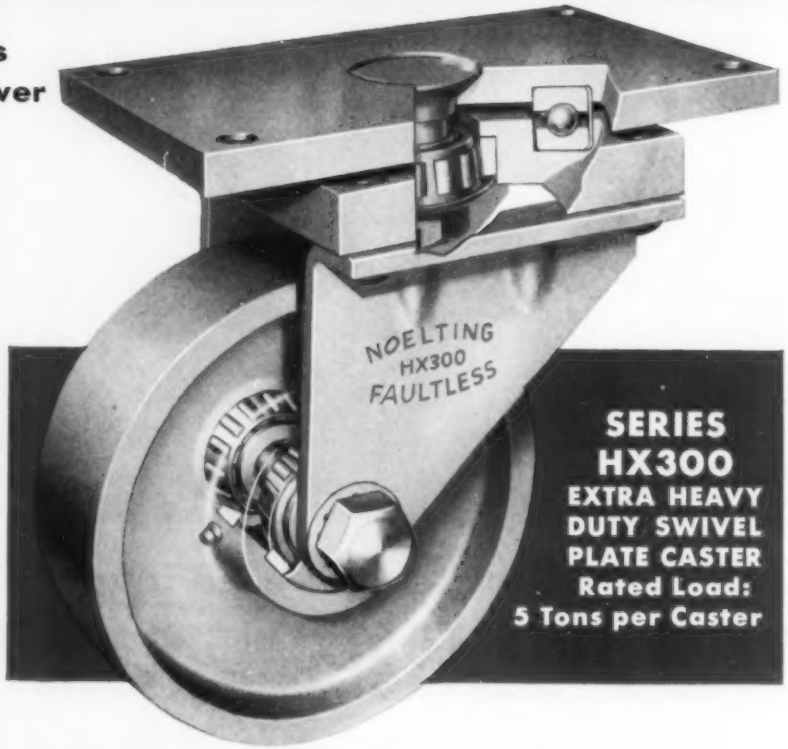

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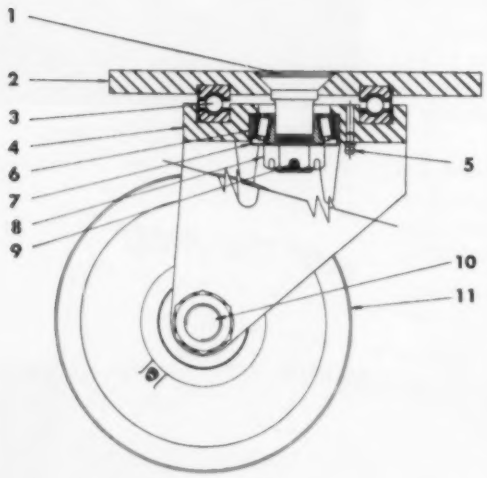

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AGE:
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Builder of the famous "DC" series of commercial aircraft.
— every six seconds of each day, a Douglas commercial airplane takes off or lands somewhere in the world.
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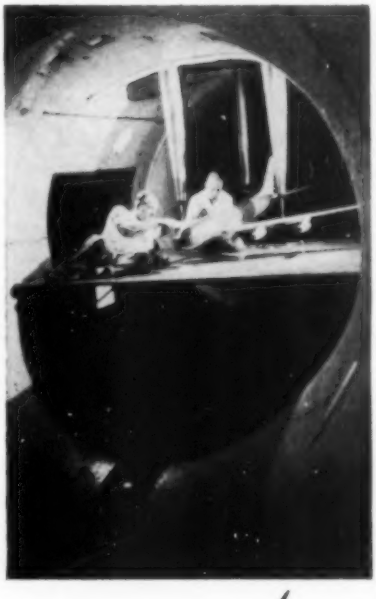

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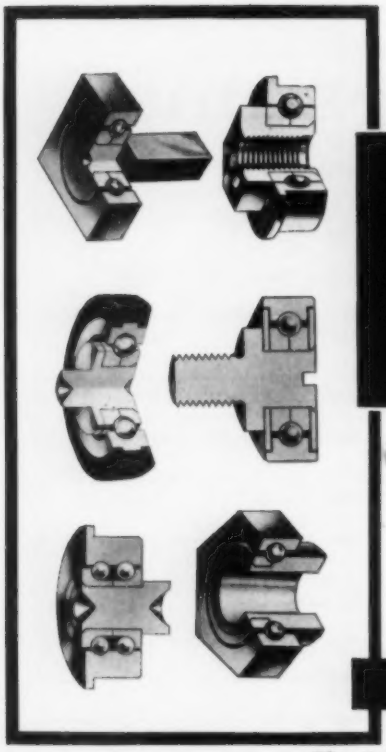

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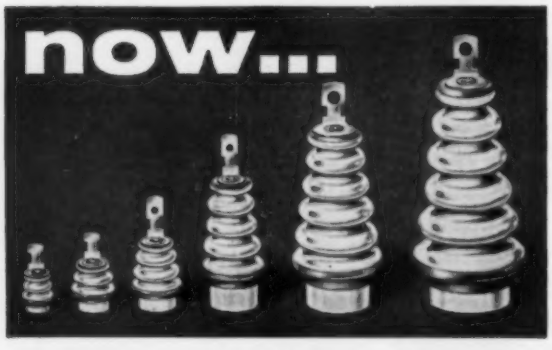

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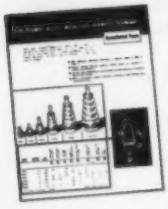

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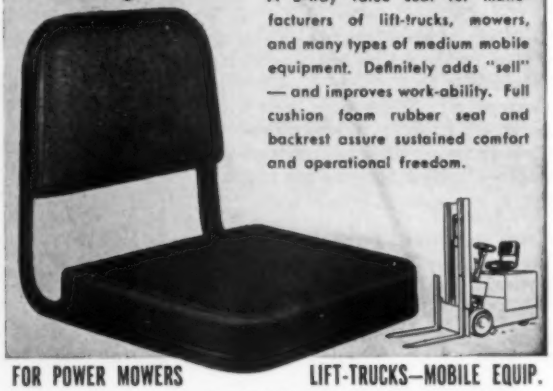

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OUR READERS SAY . . . . . .

Letters should be addressed to The Editor, *Product Engineering*, 330 West 42nd St., New York 36, N. Y.

Less Routine; More Chance

To the Editor:

Your editorial, "Raiding is not Recruiting," (Feb. *P.E.*) strikes at the heart of a current problem. Today, every effort is being made to attract more young people to the engineering and scientific professions. Some authorities propose a higher starting pay; others emphasize continued training at company expense, higher fringe benefits, and so on. While these are added inducements, the man industry is seeking is not attracted by the high salary level. It is quite probable that the foremost inducement to him is a free hand at creative thinking.

To thrive, an engineer or scientist must have the responsibility for thinking creatively. Unfortunately, not all of those employed in engineering work are capable of such thought. This is the real shortage: not *quantity*, but *quality*.

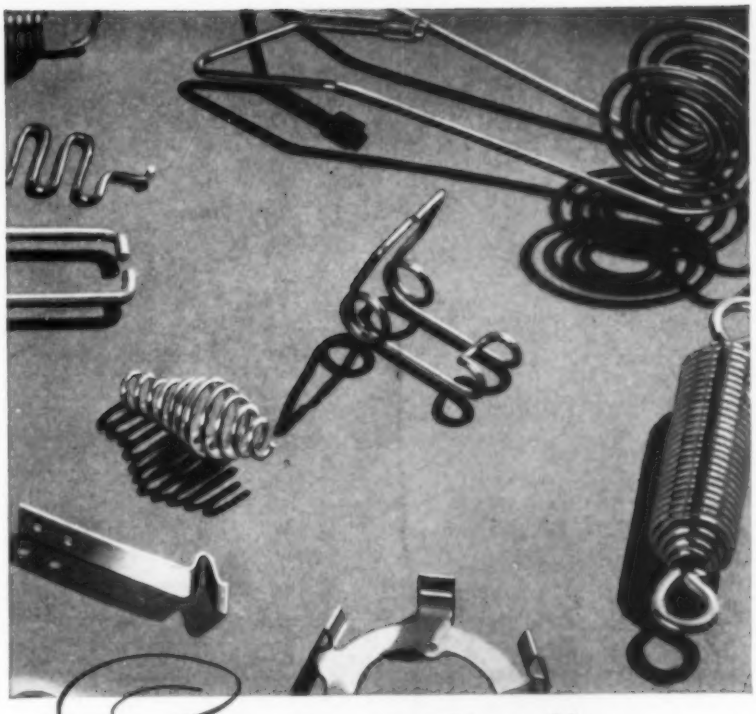
What is to be done to alleviate this shortcoming? Should the courses of our engineering schools be revised? I think not. I feel that, in this situation, industry is its own worst enemy; it is up to industry alone to attract and hold good engineering and scientific personnel.

The first thing is to recognize a man's potential. In times of grave danger or great stress, men have brought to the fore qualities of bravery and leadership which they did not know they possessed. So it is in the case of an engineer, but the basic potential is more obvious. Industry must seek out these men within its own ranks and nurture the seed of creative thinking into full bloom. To do this may require some revisions in what is generally regarded as policy, but the returns should make such an attempt worthwhile.

1. Give Routine to Clerks

The greatest deterrent to creative

(Continued on page 439)



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2

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PROBLEM: To produce precise tolerances on this complicated jet igniter afterburner valve casting for Pratt & Whitney Aircraft. Previous method involved use of core mold and five cores. Core shifting was the main problem as off-symmetry pieces caused a serious and costly problem of machining. Troubles were further accentuated in that the alloy (a very brittle material) was non-repairable. With welding impossible and 100% X-Ray and Zyglo required, defects could not be tolerated.

SOLUTION: (a) Development and use of 4 shell cores, all placed in one half of the mold and in an unmovable position, overcame problem of shifting and held close tolerances (Fig. 1). (b) Use of Shellcast® process gave a better surface finish with no defects. (c) To prevent mold deflection and loss of dimensional accuracy from weight of metal, shell molds were backed up with a special sand (Fig. 2) which hardens immediately when gassed with carbon dioxide.

Since making the change to shell molds and cores, and with the use of the CO_2 process, accuracy and finish are excellent. In overcoming core and mold shifting by the use of advanced know-how methods, off-symmetry pieces were eliminated and costs cut for Pratt &.Whitney.

Cooper Alloy, a specialist in stainless steel for 35 years, is still a pioneer in the development and application of new techniques for handling this tricky metal. Next time you have a tough casting problem, think of Cooper Alloy. *Send for your copy of our folder "Advanced Casting Know-How" today.*

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More dependable power transmission... higher capacity and longer wear life with Duti-Rated Lifetime helical gearing. Carefully controlled heat treating processes give file-hard tooth surfaces, tough ductile tooth cores.

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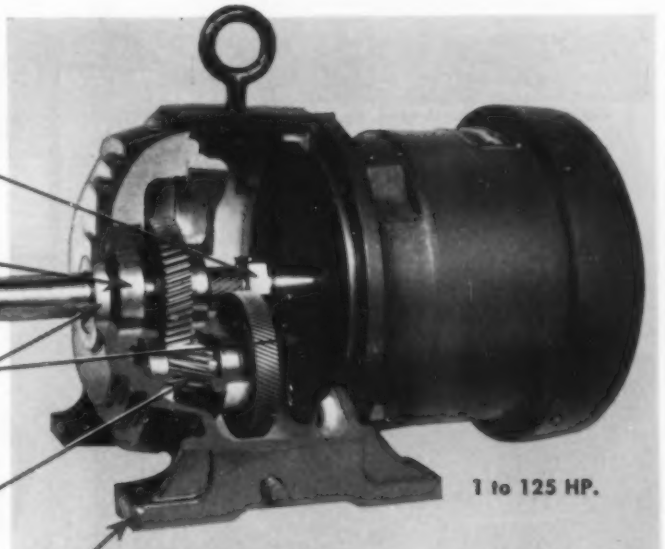
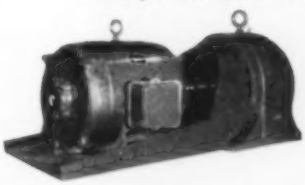
Century Gearmotors are Performance-Rated for precise application to your equipment requirements in the full Century range of motor size, speed, torque, mounting. Available in drip proof, explosion proof or totally enclosed frames.



1 to 125 HP.

Single, double and triple reduction available with output speed 750 to 7.5 RPM.

Century Gearmotor with shelf-type motor base.



Ideal for use on equipment for plants where motors must be interchangeable. Uses Century standard horizontal motor.

Investigate these improved Century Gearmotors now. For further details, call or write your nearby Century District Sales Office or Authorized Distributor.

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the long wearing, hard rubber compound that's kind to your floors.

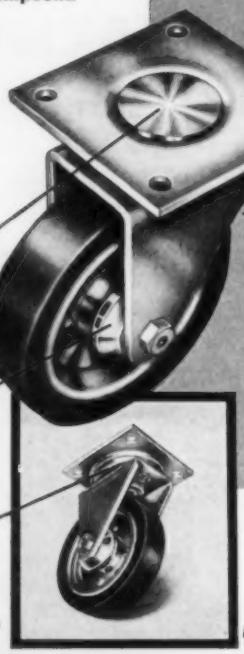
"Jarvite" high-strength, hard rubber compound performs capably in humid temperatures ranging from 32° to 100° F . . . will not develop soft spots or damage wood floors, unaffected by fats such as shortening, fruit acids, milk acids, flour, etc.

Protective stud cap shields vital grease-packed raceways from steam and hot water . . . ball bearings are packed with Atlantic Lubricant #54.

Dust and moisture shield protects cup-and-cone wheel bearing assembly from hot water, steam, lint dust, sawdust, threads, etc.

Intermediate raceway is also designed to provide a combination dust guard and moisture shield to protect the lubrication.

Model 5"-48-116



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Single Width UNIT WHEEL
SINGLE BANK SERIES (Right or Left Drive) 2 to 7 Figures; Single, 1½ or Double UNIT WHEEL

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PRODUCTIMETERS SINCE 1879 *Count Everything*

thinking today is routine. In general, engineering is so lost in routine practices that it requires considerable effort just to stay within the bounds of procedure. Creative thinking cannot be saddled with red tape without degenerating to the point at which it becomes mere repetition. Industry is cheating itself when it allows this to happen. If it is paying premium wages for the ability to think, why expend this ability on routine tasks? Such routine can often be dismissed entirely, or turned over to clerical personnel hired to attend to it. The engineer is then free to give diligent thought to the problems of engineering and manufacturing.

2. Prepare Good Men

A workable plan might be this. After a period of indoctrination wherein the engineer becomes acquainted with the company's procedure and product, he would be eligible for a position comparable with that of a project engineer. He would handle all phases of a project from design through testing, having under his supervision such subordinates as the job might require. A more experienced engineer would act as the project counselor, to keep the project engineer from making a blunder through ignorance, but the project engineer would have full responsibility for the job. As the project engineer gains confidence and ability, he can begin to work by himself, and the next eligible man will step up to his place. This would develop within both the ability to handle people, for in such a position practically all facets of a man's personality are brought out. It would then become obvious which men have potential and should be brought along to higher positions.

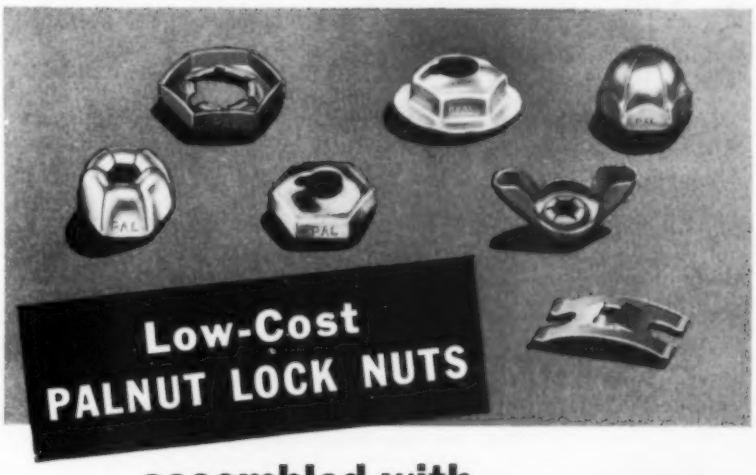
There are objections to this plan, of course. Human nature being what it is, too many people are prone to hold subordinates down. However, it is always to a person's advantage to have someone available who can take over his job at a moment's notice. At times, an opening may occur for which two men are qualified; the man who has someone available to replace himself is usually the one selected to move up.

In practically any engineering department, you will find several 10-year

(Continued on page 441)

Use this high-speed assembly method to

REDUCE – PARTS – OPERATIONS – COSTS



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Your first savings with PALNUT Lock Nuts start with low price . . . and multiply through simplified, high-speed assembly with PALNUT magnetized sockets, shanks and applicators. Made for all standard power and manual tools, these PALNUT accessories permit picking up, starting and tightening in one high-speed operation. No fumbling with hand starting. Fast, uniform tightening.

In addition, a single PALNUT Lock Nut replaces one, two, three, even four fastening parts according to application and type used. Self-locking spring grip keeps parts tight under vibration. Many types and sizes offer savings for products in every field.

• Write for catalog and booklet showing PALNUT wrenches and assembly methods. Outline application for free samples.

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TRADE MARK
LOCK NUTS

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The Heil Co., leading manufacturer of truck bodies, relies on Arens 6-D Heavy Duty Remote Push-Pull Controls to actuate hoist mechanisms. For your remote control application, consider an Arens Control in your design planning. Arens low cost standard controls can give you the benefit of quantity production. We also engineer "specials."

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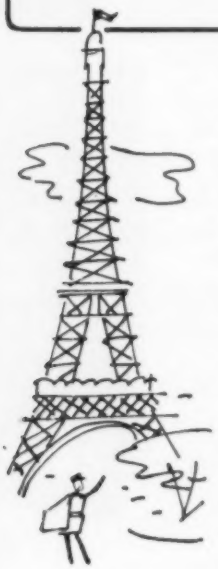

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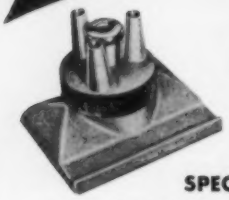

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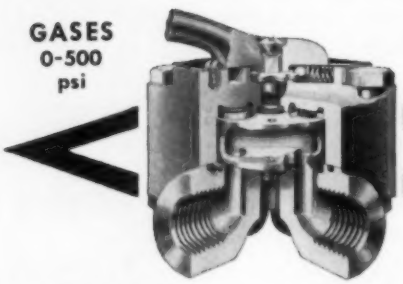

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- Turning ease
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Specifications

Contacts; Arrangement: 1 Form "C" (SPDT) Rating: 28 v DC, at 250 ma. Resistive Load.

Contact Resistance. .03 ohms maximum, .05 ohms after 1,000,000 operations at Specified Load.

Coil Operating Specifications. Pull-In: 7 MA or less. Drop-Out: 30 to 60% of Pull-In.

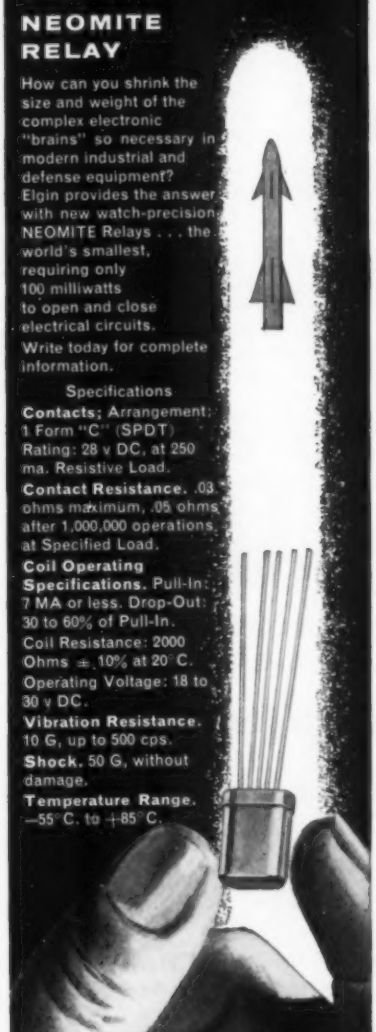
Coil Resistance: 2000 Ohms ± 10% at 20° C.

Operating Voltage: 18 to 30 v DC.

Vibration Resistance. 10 G, up to 500 cps.

Shock. 50 G, without damage.

Temperature Range. —55° C. to +85° C.



ACTUAL SIZE
.09 ounces . . . just 0.392" x 0.195" x 0.530" high.
AVAILABLE COIL RESISTANCES
—50, 200, 500, 1000, 2000 Ohms.

ELECTRONICS DIVISION
ELGIN NATIONAL WATCH COMPANY
Elgin, Illinois

Sales representatives in principal cities

men doing the same thing they did when they first joined the company. Can we say, then, that these people have ten years of experience—or would it be more accurate to say that they have one year's experience repeated ten times? If this is the case, where does the company profit? There can be no real progress if there is not sufficient growth for each man involved.

3. Seek All Good Ideas

As a general rule, project planning and preliminary design are carried out at higher levels, then passed down for detail or routine work. The result is that those men in the lower classifications are seldom given a chance to present their ideas at a time when they might profitably be incorporated into the original design. If, however, a sound idea is presented at a later stage, it is likely to be passed over because of resulting delay. The results are obvious. Many original ideas are going begging for lack of a sympathetic hearing. It is a too-common occurrence that the man with real ability is being suppressed by management when industry is begging for him. What wonder is it these men become bogged in detail and diminish in zeal?

The man Industry is so diligently seeking must feed and grow upon himself as he continually pushes back the frontier of his personal knowledge. It is then that Industry will reward itself by rewarding those who are capable of outstanding thought.

—Benjamin F. Harrison, Jr.
Ferndale, Mich.

News—or Science Fiction?

To the Editor:

The closed cycle jet article which appeared on page 212 of the Nov. 1956 issue was interesting but it should have appeared under the heading, "Science Fiction", rather than "Technical News." Perhaps you knew it was false but published the item with a straight face, to check on reader response.

If Mr. Landini claims this engine has been "developed," I accuse him of falsehood as well as technical ignorance, since to me the word "developed" means that operation has at

(Continued on page 443)

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Formed Tubes...

★ **Save Time**
We have a huge stock of dies and, when needed, tooling's fast. We also avoid delays by making our own electrically welded steel tubing, sizes from ⅝" to 3" OD.

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Long, active experience with all tube forming processes and high standards of quality control make sure your orders will be completed *right.*

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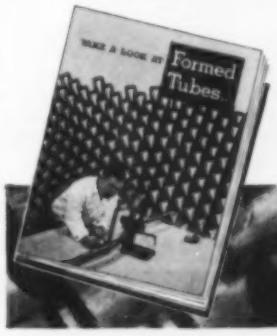
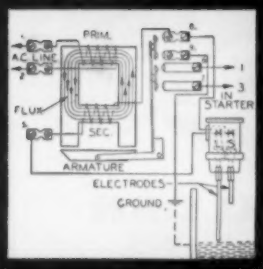
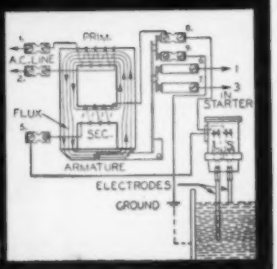


LIQUID LEVEL CONTROL with the B/W RELAY





Type LH Relay for Pump Down Control

POSITIVE AND DEPENDABLE

The B/W system of liquid level control consists of a transformer type induction relay and a holder for one or two electrodes, depending on the desired operation and the type of relay used. The relay incorporates a primary or line voltage coil connected to a permanent source of alternating current, and a secondary or electrode circuit coil connected to the electrodes immersed in the liquid being controlled. Energizing the primary coil causes an induced voltage in the secondary coil; thus the secondary coil is never connected to the power line.

LIQUID IS ELECTRICAL CONDUCTOR

The liquid itself is the electrical conductor that completes the secondary circuit. When this secondary circuit is completed, by the liquid contacting both electrodes, the magnetic attraction set up in the legs of the relay core causes the armature to close, and open or close the load contacts. A built-in holding circuit maintains this contact until a predetermined fall in liquid level breaks the circuit. By adjusting the electrode settings, the range of operation can be controlled.

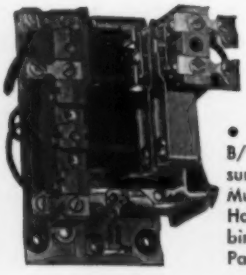
FOR PUMP UP and PUMP DOWN APPLICATIONS, SIGNALS and ALARMS

B/W relays are designed for either pump up or pump down operation. In addition, by using a single electrode they are well suited for signal and alarm applications.

NO MOVING PARTS

The complete absence of moving parts in the liquid insures long and trouble-free performance. Because of the very low current in the secondary circuit these relays are ideal for many switching jobs outside of the liquid level field.

Consult our engineering department on any special control applications.



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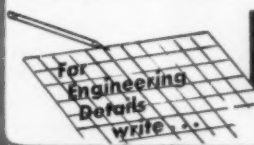
AUTOMATION!

DESIGN YOUR CONVEYORS TO *Cushion* PARTS ON STILSON *Rubber Rollers*

Stilson Rubber Rollers provide the perfect cushioned, scratch free ride for all types of production parts.

Used on gravity conveyors, die lifters, or idler rolls under conveyor belts, Stilson Rollers assure positive surface protection during transportation and safety for glass or other fragile products.

Stilson Rollers are available in 2½ and 4 inch diameters and in a variety of models. They operate on a dual ball bearing axle and all parts are interchangeable.



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Save 60% Fastening Time!

- HOLD PERMANENTLY
- DISASSEMBLED EASILY WITHOUT DAMAGE TO COMPONENTS

Quick, simple insertion . . . Drill Hole and Drive Stud with a single blow.

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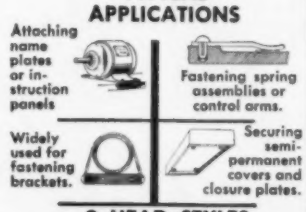
Attaching name plates or instruction panels
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Widely used for fastening brackets.
Securing semi-permanent covers and closure plates.

3 HEAD STYLES

Driv-Lok Studs save time and reduce costs in fastening name plates, covers, brackets, panels, etc, to heavier sections and for countless other applications involving light-to-heavy member fastening. Once installed, Driv-Lok Studs will not vibrate loose or fall out — yet they can be easily removed without damage to components. Made in 3 head styles. Write for illustrated catalog sheet, prices and samples.

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least been demonstrated. His engine, if it is indeed a closed cycle, can generate no thrust, in space or elsewhere.

The thought of developing a continuing force, lift, or thrust without external reaction, in opposition to Newton's first law of motion, has been popping up in different forms for centuries. In its simplest configuration it is known as bootstrap lifting. So far, Newton has won out—the ideas didn't work any more than perpetual motion works.

Mr. Landini's proposed condensation of the gas which provides his reaction mass clouds the issue temporarily, but it soon becomes evident that condensing the gas changes neither its mass nor its average lineal velocity. Therefore the negative thrust force developed on the rear wall of the engine by the deceleration of the condensed gas will precisely cancel the thrust developed on the front wall by the acceleration of the hot gas, regardless of how the rear wall is disguised in the form of a "closed tubular spiral."

—Francis D. Reynolds
Seattle, Wash.

To the Editor:

In your Nov. issue you have described a closed cycle jet for interspace flight which was "developed" in Italy. May I suggest that you send your reporter (and the ingenious Italian scientist) to an accredited school for a course in high-school physics.

Should there be further information

(Continued on page 445)

Now...Cannon-Muskegon offers complete

VACUUM MELTING service and UltraMet alloys...

Now available are:

stainless, tool and die, magnetic steels—high-temperature, corrosion-resistant, expansion alloys—bearing steels—electrical and electronic alloys—special alloys

RIGHT NOW . . . Cannon-Muskegon provides you with a ready source of super-clean, superior strength alloys to meet complex metallurgical applications. Our completely equipped and expertly staffed vacuum melting facilities as well as chemical, physical and metallurgical laboratory can help you *find, test and produce* vacuum melted alloys for any application . . . in test or production quantities . . . with accurately predictable properties.

Ferrous, nickel and cobalt-base alloys are poured at pressures from 1 to 10 microns — resulting in extremely clean metals for smoother surfaces . . . greater tensile strength, ductility and wear life . . . and higher electrical and magnetic properties. Contact Cannon-Muskegon for facts.

We offer industry

- ***Materials for remelt*** — under conventional air melting, inert gas, vacuum.
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Finest laboratory and production equipment is used in our vacuum-melting operation . . . available to you. Let our metallurgical specialists help you solve your alloy problem.

For full particulars write for our New Bulletin on Vacuum-Melting and Air-Melting facilities, products and service.

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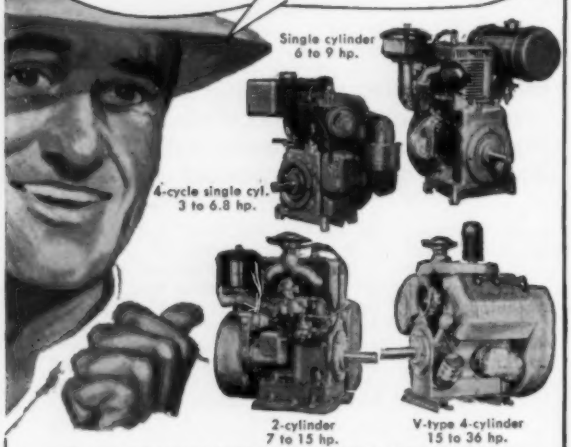
Your customers get all the

POWER

they pay for... All the time
when you Specify

WISCONSIN *Heavy-Duty*
***Air-Cooled* ENGINES**
for Your Equipment



Your customers don't pay for "part-time power" when your equipment is "Wisconsin-powered". These heavy-duty, industrial-type, air-cooled engines are built with the ruggedness and basic High Torque design that deliver Load-Lugging horsepower day-after-day, month-after-month. Downtime and repairs are held to an absolute minimum because these engines have the endurance and stamina to operate under difficult conditions with only routine maintenance and attention.

Extra-capacity AIR-COOLING means fewer restrictions on engine location—operating equally well at extreme sub-zero or at temperatures up to 140° F. They start easily in any weather, thanks to the high-tension, impulse-coupled OUTSIDE magneto. Pump-circulated lubrication in all models for long-life, low-maintenance service. And heavy-duty components throughout mean dependable operation — even in rough going.

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Standardize on Wisconsin Engines and your customers take the dividends in economical, dependable power. Tell us about your power problem and get a prompt quotation on the unit best suited to your equipment. Write for "Spec" Bulletin S-195.

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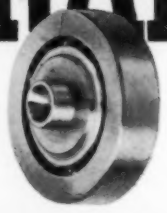
GENERAL



radial stud type bearings
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Low-Speed, Positive Drives or Motion Transfer
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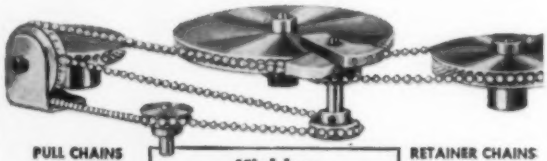
Swivel-like Bead Chain and special non-slip sprockets make any drive possible . . . at low cost . . . eliminates expensive gears, universal joints, etc. Perfect for inaccessible locations!



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Chain of a thousand uses! Low cost, attractive, easy to use! 5 Sizes: 3/32" to 3/8". Strengths 20 to 200 lbs.
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THE BEAD CHAIN MFG. CO.
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that makes this scheme feasible, I would be happy to hear of it.

—E. NEU, JR.
Caldwell, N. J.

To the Editor:

On page 212 of the Nov. issue mention is made of a closed cycle jet for space flight.

Since jet propulsion depends entirely upon the reaction to ejected mass, condensing the ejected mass and returning it to its origin merely sets up an equal and opposite mass flow so that net thrust equals zero. This proposal is even sillier than perpetual motion—all that terrific energy expenditure for nothing!

"Product Engineering" is too good a magazine to let it be spoiled by letting errors creep in.

—DICK HAUTZENROEDER
Detroit, Mich.

Ed.—We are in the process of contacting Mr. Landini in Italy, to see if he can supply us with any further details on his device.

Thorium Toxicity of Mg-Th Alloy

To the Editor:

Your article, "Magnesium-Thorium Alloy," which appeared in Nov. 1956 was very interesting. I noticed that the fact that thorium is radioactive was not mentioned in the article. It is less radioactive than uranium 238 by a factor of about 3 and emits alpha particles of about the same energy as this isotope of uranium.

If the radioactivity is small enough so that no personnel hazard exists in these applications, it still should be mentioned with the evidence that this is so.

—L. DAUM
Westinghouse Electric Corp., Pittsburgh, Pa.

Ed.—Personal hazard in fabricating HK31A due to radioactivity was not mentioned in the November article because of the following statement appearing in "HK31XA Magnesium Alloy Sheet and Plate" (revised Aug. 3, 1956) from Dow Chemical Co., producer of the alloy:

"Only long exposure to fine dust or fumes need cause concern as to radioactive toxicity of Mg-Th alloys.

(Continued on page 447)

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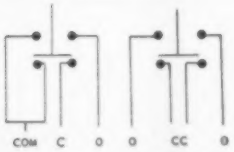
with the
ACRO
SUBMINIATURE
SWITCH

ACTUAL SIZE

CIRCUIT ARRANGEMENTS



DOUBLE THROW DOUBLE CIRCUIT

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of 5 New
Actuators

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With its small size, high capacity, and newly-designed actuators, the Acro Subminiature Switch meets an exceptionally wide range of design requirements . . . provides many new development possibilities for subminiature assemblies.

The electrical rating of this precision Acro Snap-Action Switch—10 amperes at 125 or 250 volts A.C. or 28 volts D.C.—is over four times that of most switches this size. It will operate within a temperature range of from +350° to −80°F., and its terminal arrangement permits wiring double circuits.

Switching mechanism is enclosed in a durable plastic case which can also be adapted to various types of present actuators and mountings not shown.

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Columbus 16, Ohio
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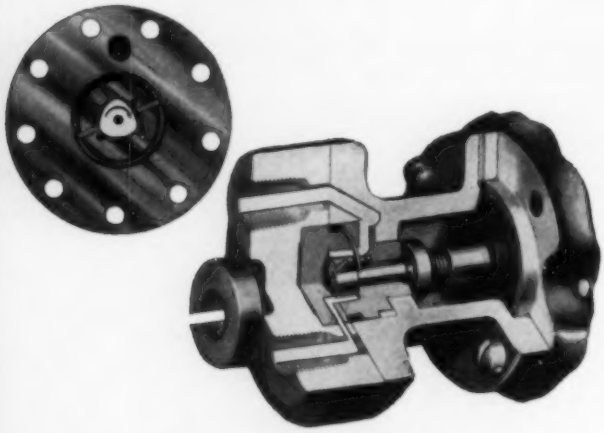
FLUID METERING PUMPS

Positive Displacement Rotor Type. For Industrial Applications, Aircraft Anti-Icing and Aircraft Fuel.



IT'S SO SIMPLE!

The rotation of the rotor draws the fluid in through two passages, filling the cavities formed by the three lobes of the rotor. This fluid is sealed within these small cavities until it is forced through the two outlet holes by the floating blades. The flow may be kept uniformly divided through two outlet ports, or may be combined internally for passage through a single port.

Compact • Light Weight

Send for Weldon Manual and Catalog with detailed specifications and installation drawings, covering the full range of Weldon pumps in various capacities. Specify your requirements.

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Positive power transmission of roted load. Gear teeth on end castings match special rubber tube section.

- **Load ranges—2½ H.P. to 25 H.P.**
- **Shaft sizes—¾" to 1⅞".**
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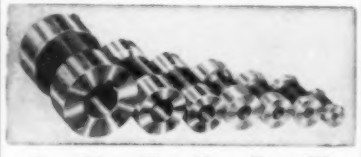
- **Prevents end thrust.**

Dyna-Line . . .

The finest flexible coupling in single unit construction—specifically designed for fractional H. P.



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- **True Flexibility and Torsional Resilence for quiet, load-plus power transmission without extreme deflection or twist.**
- **Lengths varied to design specifications in each series.**
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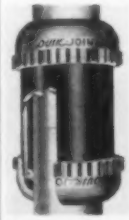

- **UL approved for hazardous fluids**
- **Guaranteed for 2000 p.s.i.**
- **Allows 7° angular deflection.**
- **No threading of pipe required.**

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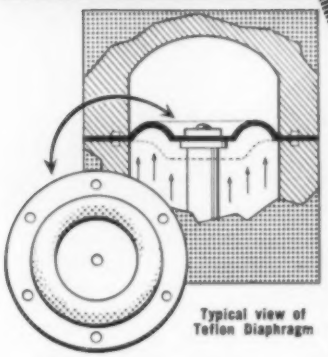
CUSTOM MOLDED **TEFLON***

*DuPont's Tetrafluoroethylene Resin

IN THIN SECTIONS AND SHAPES!



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Look to Sparta, pioneers in the development of custom molded Teflon parts (Pat. No. 2,781,552). Our highly trained Fluorocarbon engineering staff... modern manufacturing methods, are available to help you solve any design problems you may be experiencing with ordinary flexible materials.

The unique combination of properties of Teflon offers economical and product improvement opportunities never before possible.

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We carry a COMPLETE STOCK of all standard Teflon products.

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The first cost can be the least . . . if it is the last cost.

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Division of United States Ceramic Tile Co.

DOVER, OHIO PHONE 4-2380

WESTERN DISTRICT OFFICE

Phone: ANGELUS 3-6359 Los Angeles, California

Normal dust control precautions, followed to avoid fire hazards, can be expected to control any health hazards that might result from fine dust in grinding HK31A alloy.

"In welding Mg-Th alloys without local exhaust, concentrations of thorium above the tentative limit of 0.1 mg per cu mm of air were found in the breathing zone. Use of local exhaust reduced thorium concentrations well below accepted limits. If ventilation is such that visible fumes flow away from the welder, it probably is adequate. An alternate practice involves use of ventilated welder's hood.

"For indoor storage of sheet and plate, size of storage stacks of sheets should be limited to 1000 cu. ft. Aisle widths should not be less than one-half the height of stacks; aisle widths equal to the height of stacks are recommended."

Should Westinghouse experience with Mg-Th alloys indicate these general safety rules to be inadequate, we would like to have the opportunity of reporting this information at an early date.

Correction

To the Editor:

On page 165 of the article, "Detecting Symmetric Switching Functions", Fig. 1, the first term in the algebraic function should read AB′C′ instead of AB′C. Also, the second paragraph above Table 1 defines an *m* out of *n* network in terms of one specific type (three out of five), rather than giving the more general definition.

The original copy for this paragraph read as follows: "The *m* out of *n*′ type of network (for example, a network which is closed when any three (m) out of five (n) relays are operated) is related to symmetric functions. . . ." I'm sure you will agree that this small omission considerably changes the intended meaning.

On page 166, the fourth term in the algebraic term printed as S_2 A,B,C, instead of A′BC′, as shown. Also, the algebraic term printed as S_2 (A,B,C, D, E′). This term is printed correctly in the drawing of Fig. 4.

—George E. Beers
International Business Machine Corp.
Endicott, N. Y.

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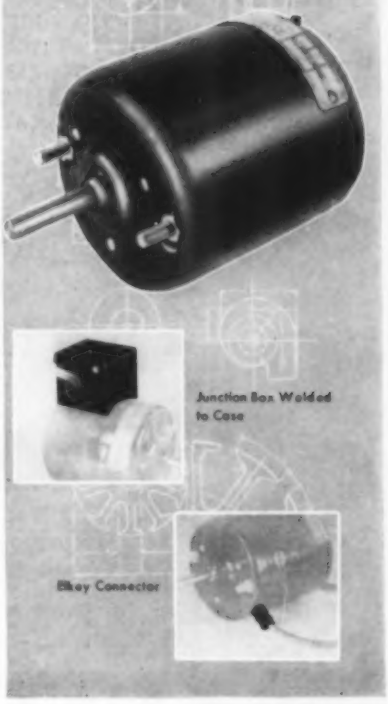

TYPE D INDUCTION MOTOR for trouble-free performance

This 2-pole shaded pole induction motor has a free speed of approximately 3400 rpm, with recommended load speeds of 3000 and 3100 rpm. Available for 115 V AC, 60 cycle operation, CW or CCW rotation.

Different voltages or 50 cycle operation available on request. Other variations include ventilated case, junction box welded to case or Elkey connector. Choice of mountings — flat strap bracket, saddle type bracket or resilient plate.

Heinze motors are also designed to your exact specifications. Write Dept. F for free catalog.

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SUB-FRACTIONAL HORSEPOWER MOTORS AND BLOWERS

1
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Contact Blade Spacer
Coil Form
Coil Form Insulator Bushing
Coil Form Terminal Board
Shoulder Washer
Germanium Crystal Holder
Stand-Off Insulator
BEFORE YOU SPEND TIME AND EFFORT TO DESIGN YOUR OWN MOLDED PLASTIC PARTS — THINK OF SAVING THAT COST, PLUS TOOL COSTS, WITH THESE GRAYHILL STOCK PARTS. ASK FOR COMPLETE INFORMATION AND CATALOG.
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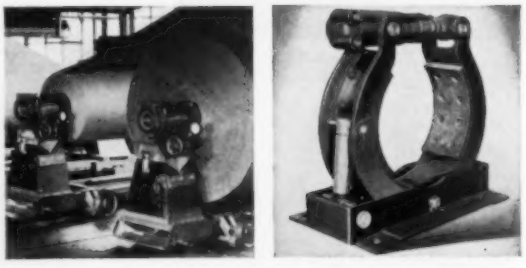
USE WAGNER ACTUATING SYSTEMS AND INDUSTRIAL BRAKES...

for Tension Control, Emergency Stops



Wagner Industrial Drag Brakes on the paper mill roll stand shown here, keep tension on the roll as paper is fed out to other machinery. Brakes are actuated by a Wagner control cylinder, which is operated by a hand wheel. A Wagner Type H Brake is used in this application.

For *your* specific applications, Wagner can furnish engineered kits with actuators, controls, tubing, fittings —everything required for complete installation. Your nearby Wagner field engineer will get you detailed specifications on a system for your particular application. Call him today.

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EXPLOSIVE VALVES

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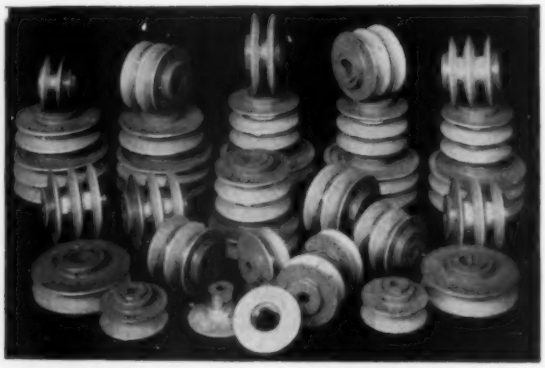
7811P SHERIDAN DRIVE, **BUFFALO 21, N. Y.**



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FIRST
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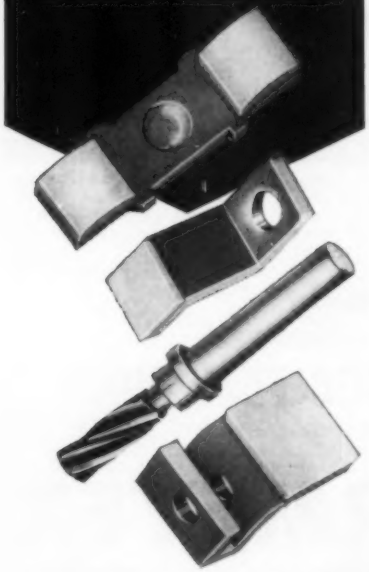
IN MAKING
CONTACT ASSEMBLIES



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- **COMPLETE SERVICE** Gibson offers a complete line of contact materials, forms and assemblies to fill requirements of your product.
- **FLEXIBILITY** Gibson's versatility in adapting the right Gibsiloys or other contacts to your product—coupled with round-the-clock production—enables us to give you what you want . . . on time. Our one field is electrical contacts. Consult Gibson first about contacts.

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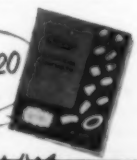

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Manufactured by
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PRESS PREVIEWS

Key to Increased Automation

"Industrial America—1976," was the topic for the most recent of General Electric's forums on Industrial Productivity. Among the speakers was Dr. L. T. Rader of the General Electric Co., who predicted that, "Control will make tomorrow's product economical to build and buy." He further said that in the future "controls, particularly electronic controls, will be increasingly vital to the expansion, cost reduction, and speeding of manufacturing processes." He cited the following as tools that are bringing America's industrial future into focus.

Computers which are speeding calculations, performing routine mathematical tasks, and helping eliminate the costly and time-consuming communication barriers between engineering concept and finished product.

Product controls which store the information and provide error-free automatic guidance to industry's machines.

Adjustable speed drives speeding and coordinating material handling and machine processing.

Photoelectric and other visual tools counting, sorting, testing and inspecting at speeds beyond human capacity. Only automatic electronic inspection and quality control can stay with the production line speeds of tomorrow.

"The automatic factory is really only as far away as our ability to take full economic advantage of these tools," Dr. Rader said. "Automation will come with our ability to forecast accurately, to standardize, and to apply these available tools and techniques and their refinements."

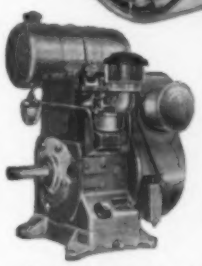
Automatic Finishing for Die Castings

Precision Castings Co., a division of Harsco Corp., has completed a series of automatic finishing departments to augment operation at its plant in Syracuse, N. Y. The new facilities, costing more than $\$\frac{1}{2}$ million, include

(Continued on page 451)

Will stepped-up performance increase sales of your power equipment?

Specify ONAN
SHORT-STROKE, LONG-LIFE
ENGINES



Model CCK
12.9 H.P. 2-cylinder opposed . . . 4-cycle. Gasoline-powered.

Model AJ
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Onan short-stroke, air-cooled engines give you a combination of performance characteristics which can add *powerful selling features* to your engine-driven equipment. They are designed for continuous service . . . to run hundreds of hours with minimum attention. Short-stroke, low-friction design, extra-large bearing surfaces, Stellite-faced exhaust valves, solid Stellite exhaust valve seats and many other long-life features give you a big premium in trouble-free service.

Onan engines are compact in all dimensions, light in weight, smooth running and easy starting. They deliver full rated power even under a variety of adverse conditions.

If stepped-up performance will sell more equipment for you, you can build in this extra saleability with Onan engines at no extra cost. Write us or call.

D. W. Onan & Sons, Inc.
3819 Univ. Ave. S.E., Minneapolis 14, Minn.

Lightweight, air-cooled Onan Diesel engine

Model DRP
Two-cylinder, opposed. 15 H.P. at 2300 R.P.M. 4-cycle. Solid injection, full Diesel. Electric starting. 12-volt generator. Full pressure lubrication.

Onan ELECTRIC PLANTS
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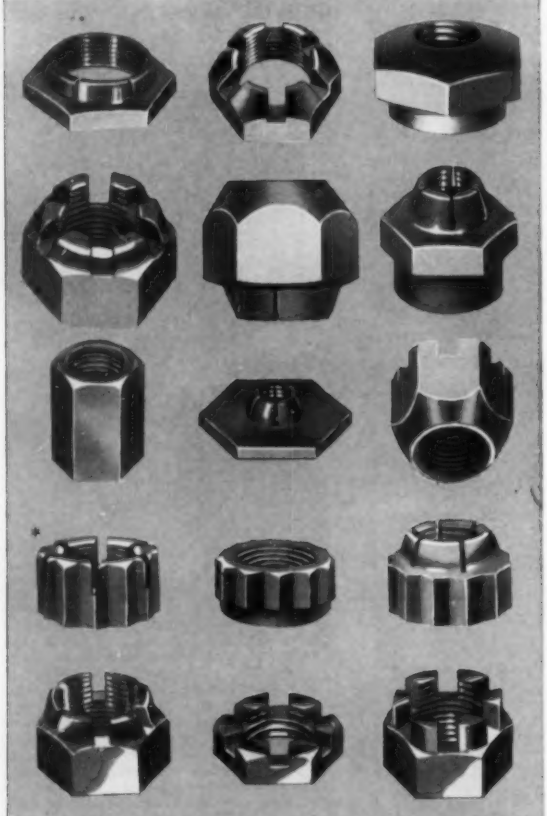
ENGINES

SPECIAL NUTS

to specs. 7/16" - 4-1/4" cross flats

special machines + large stock of material × years of experience = speedy deliveries high quality low prices



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*Also 12 Pointer brochure on request.

NATIONAL MACHINE PRODUCTS COMPANY

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New or improved product design takes *all your knowhow.* Dormeyer *Solenoid Engineers* can contribute to your efforts with electro-mechanical devices that carry out your ideas *and even stimulate more.* Dormeyer Solenoids have streamlined appearance, simplified operation, allowed "package" maintenance, and increased service life of many products. Let's talk about yours:

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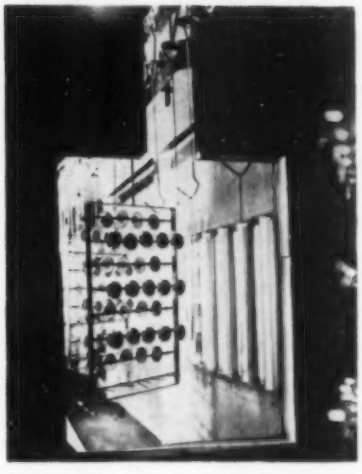

DIE CAST TV tuning knobs entering bake oven.

automatic equipment for cleaning, copper-nickel and chrome or brass plating, phosphate coating, electrostatic spray painting, baking and polishing. The company designed its own multi-station cleaning cycle. Cleaning and plating units have separate conveyor systems so cycle times can be controlled independently for more adequate cleaning.

Automatic polishing equipment includes application of buffing compound as well as flexibility in handling parts of various size and shape. An automatic phosphate coating line is designed to produce a controlled coating of 200 mg per sq ft. Spray painting installation uses electrostatic method adaptable to wrinkle finish and metallic paints. Continuous 12 x 25 ft baking oven combined radiation and convection to give equivalent of a 30 min bake with only 20 min in oven. Heat from infrared lamp is supplemented by Calrod tubes at entrance to bring parts to temperature quickly.

Midwestern Plant For Small Tubing

A building now under construction at Wapakoneta, Ohio, for Superior Tube Co., will more than triple the floor space of the company's present leased facilities and will boost its production of small tubing and electronic parts by 30 per cent. In the new 63,000 sq ft plant, tubing will

(Continued on page 453)

STOW FLEXIBLE SHAFTING
The Ideal PTO Drive

1¼" flexible shaft under tractor-trailer transmitting 10 HP.

1¼" core assembly pulled out of casing. Note steel-backed bronze sleeve bearing.

Here are five big reasons why flexible shafting is an ideal power take-off drive on trucks and tractor trailers.

FLEXIBLE SHAFTING:

1. **Can connect a drive shaft and a driven shaft which are working at different angles and located in different planes.**
2. **Eliminates the need for accurate alignment.**
3. **Eliminates dangerously exposed revolving parts; no safety guards required.**
4. **Replaces connections affected by vibration.**
5. **Is economical because it is so easy to install and maintain.**

Available with built-in bearings and couplings in sizes from ¼ inch to 1¼ inches in diameter—STOW flexible shafting can help solve your trucking and maintenance problems *in advance*. The know-how of 82 years' experience goes into every STOW flexible shaft!

STOW flexible shafts are being used on trucks and tractor-trailers to:

- Operate pumps for petroleum, other liquids and hydraulic pumps on dump trailers.
- Operate conveyors for grain and coal.
- Operate compressors on refrigeration trucks.

Our Engineering Department will be glad to work with you on any special drive problems. For complete data on flexible shafting sizes, torque capacities, and other specifications, write for STOW Engineering Bulletin, No. 570, and Tractor-Trailer Bulletin, No. 542.

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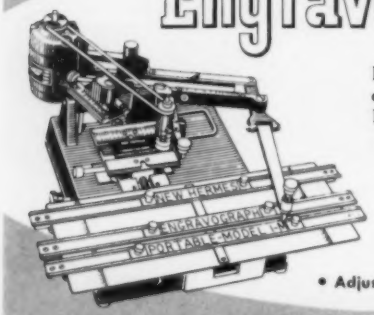

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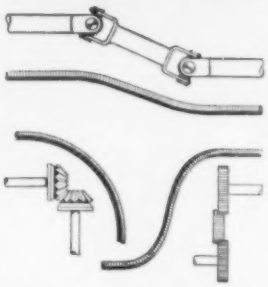
FLEXIBLE SHAFTING ELIMINATES GEARING



Flexible Shafting eliminates the noisy and cumbrous gearing used in conjunction with solid shafts. It has the ability to transfer power from remote places, over, under, and around obstacles found in the path of installation between the drive and the driven units. Flexible Shafting requires very few parts, making them inexpensive; whereas solid shafts using universal joints, miter gears, and gear trains, many times would not be feasible because of their noisiness or lack of economy. With a Flexible Shaft assembly, design may be simplified and your engineering time spent on other necessary component parts without having to worry that they will create obstacles when placed where you want them.

Flexible Shafting cuts down on vibration thus offering long life with very little maintenance required. For complete Flexible Shaft information, write F. W. Stewart Corporation, 4311 Ravenswood Ave., Chicago 13, Illinois.

TROUBLE-FREE BEARINGS

...where it counts the most!

KARAK is a mixture of graphite and other forms of carbon. Self-lubricating, it solves bearing lube problems many times, many ways. It provides freedom of design for the inaccessible bearing. Adaptable grades meet varying factors of speed, load, temperature, pressure, and material to be handled. Unlike metals, it will not melt or seize. It will not distort under heat. Results are greatly extended bearing life and reduced maintenance.

Write factory today for free sample KARAK bearing, and information sheets No. 1164-74.

The OHIO CARBON COMPANY
12508 Berea Road, Dept. 285, Cleveland 11, Ohio

TRU-O-SEAL
TEFLON SEAL

PAT. PENDING

STOPS PIPE THREAD LEAKS

Satisfaction Guaranteed Or Money Back TRIAL OFFER

TRU-O-SEAL Fittings are guaranteed to seal pipe thread connections permanently against all oils, practically all known chemicals and gases; to seal under high pressures or vacuum; to withstand —280° to plus 500° F.; to eliminate "overtightening" damage and pipe dope. Available in ⅛" to 2½" pipe thread sizes.

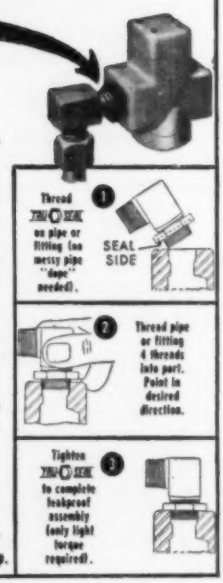
$10.00 Trial Offer No. 1: eight ⅛", ten ¼", eight ⅜", ten ½" pipe thread TRU-O-SEAL Fittings.

$10.00 Trial Offer No. 2: eight ½", ten ¾", four 1" pipe thread TRU-O-SEAL Fittings.

Send order to

TRU-O-SEAL DIVISION
Flick-Reedy Corporation
2002-04 N. Hawthorne Melrose Park, Ill.

"Miller Fluid Power" is also a Div. of Flick-Reedy Corp.


1
Thread TRU-O-SEAL on pipe or fitting (no messy pipe "dope" needed).
SEAL SIDE
2
Thread pipe or fitting 4 threads into part. Point in desired direction.
3
Tighten TRU-O-SEAL to complete leakproof assembly (only light torque required).

be made in sizes up to ⅜ in. OD, eventually to be increased to ½ in. OD. Materials will include several types of stainless steels, nickel and nickel alloys and glass sealing alloys.

In addition to production of small tubing, the Wapakoneta plant will supplement production at its home plant at Norristown, Pa., of Superior's nickel cathodes and provides production space for Johnson & Hoffman Corp., a Superior affiliate which manufactures stamped and deep drawn electronic parts. New equipment planned for the plant includes drawbenches for drawing tubing, an annealing furnace for high-temperature alloys and stainless steels and associated facilities. Employment is expected to reach about 330. The plant is scheduled for completion by mid-November.

Research on Nuclear Reactor Design

New facilities costing more than $1-million were completed at the Knolls Atomic Power Laboratory (KAPL), Schenectady, N. Y., for General Electric. The laboratory houses two nuclear reactors for experimentation and an International Business Machine's 704 digital computer for analysis of research problems.

KAPL is operated by the General Electric Co. for the Atomic Energy Commission. Dr. W. R. Kanne, manager of Advanced Development Activity at KAPL, said that the facility is being installed to help meet reactor requirements "with less margin for error" than has ever been possible. He said that use of the new computer facilities will necessitate doubling the previous laboratory staff for mathematical analysis. Experimental reactors in the building will produce no power or heat, but will be used to obtain physics and nuclear design informa-

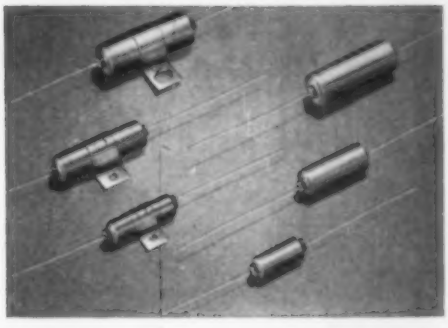
(Continued on page 455)

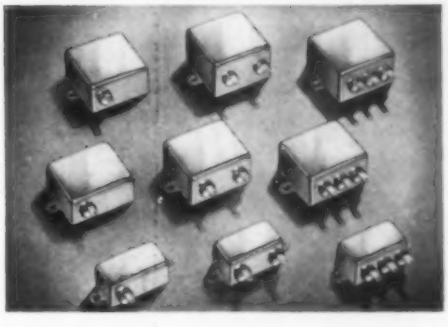
Credit Omitted

Through error the illustrations in Fig. 4 for the article "High-Speed Electrostatic Clutch" in the February issue on page 191, were not credited to the "IBM Journal of Research and Development," where the illustrations first appeared.

potter *Metallized Mylar** CAPACITORS

SMALL SIZE 100 VDC CAPACITORS FOR TEMPERATURES OF 125°C and 150°C





IMPREGNATION: Epoxy Resin (150°C only)

TEMPERATURE RANGE: −70°C to +150°C.

SEAL: Hermetic.

CONTAINER: Hot tinned steel can for extra protection against humidity.

TOLERANCE: ±10%. (Other tolerances available upon request.)

TERMINALS: Silicone bushings with standard solder lug terminals. Side terminals standard; also available with top or bottom terminals.

WINDINGS: Non-inductive to insure efficient operation over a wide frequency range.

TESTING: Tested at twice the rated voltage.

**"Mylar" is a registered DuPont trademark for its brand of polyester film*

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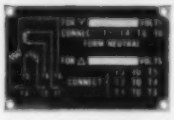

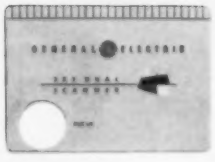

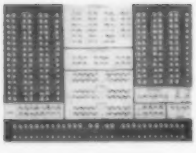

Cutting your engineering costs is routine for U. S. RADIUM CORPORATION. As the only company in its field to provide all standard techniques for marking data display parts, USR is in position to recommend the most economical method or combination of methods for fabricating instrument dials, control panels and original equipment nameplates to your requirements.

UNITED STATES RADIUM CORPORATION currently offers both the light transmitting plastics and metals such as aluminum, brass, stainless steel and nickel silver as stock blanking materials. A wide range of colored or luminous durable finishes may be applied to these materials by any of the following processes:

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- **Photo-reproduction in LACKON® finishes**
- **Mechanical engraving**
- **1-up offset**
- **Etching**
- **Lithography**

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Modern industrial electronic engineering has been coordinated with electric motor design to provide a versatile means for obtaining the full possible advantage of speed control in DC motors while operated from the regular alternating current power line. Grid controlled "Thyratron" tubes are utilized for power controlled stepless variation to supply motor armature power. Patented feedback, or "Servo" circuits provide constant torque capability over wide speed ranges of as high as 60 to 1 in some models and a minimum of 20 to 1 in others.
Servospeed
DIV. of ELECTRO DEVICES, Inc.
4 Godwin Ave., Paterson, N. J.
ARmory 4-8989

tion connected with the development of nuclear power plants. The building will be a two-story, reinforced concrete structure, housing about 90 persons.

Polyolefin Resin Plant In Production

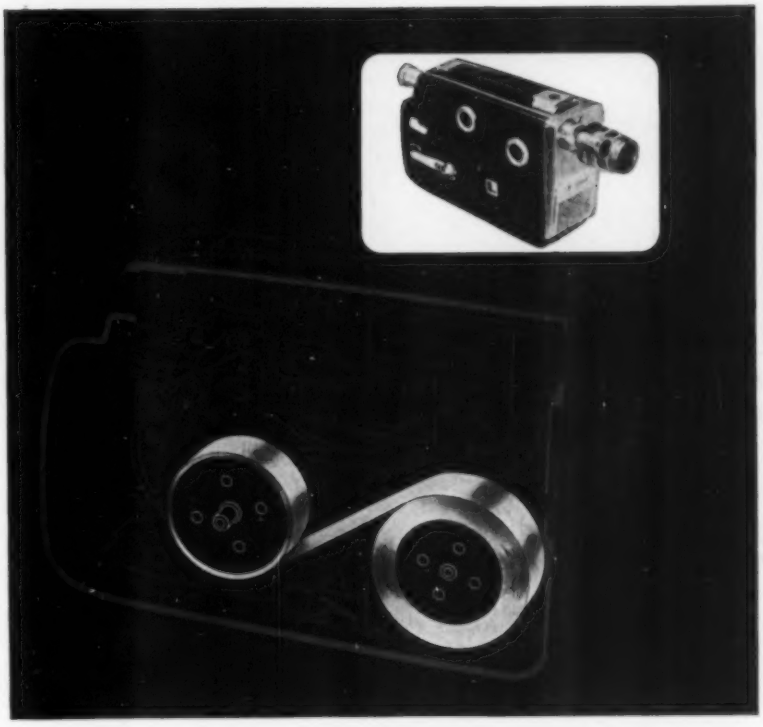
Celanese Corp. of America announced that its new 40-million-pound-a-year plant for making polyolefin resins near Houston, Texas, began production in February. A development unit has been operating for some time. The new resin, made under license from Phillips Petroleum Co. is an ethylene polymer and a member of a new group of plastics sometimes referred to as "low-pressure polyethylene," and represents a new plastics development.

Products made of this material will resemble in some respects those made of polyethylene, but will provide combinations of rigidity, heat resistance, toughness and chemical inertness not available in polyethylene. They will withstand prolonged exposure to live steam, and will not become brittle even at — 180 F. Among the varied applications foreseen for the new resin called Fortiflex, are wire and cable insulation, bottles, industrial housings, automotive parts and pipes and fittings.

Research Laboratory For Fiber Glass

A new building to house research and engineering facilities for five affiliated molded fiber glass companies has been completed in Ashtabula, Ohio. The 6000 sq ft structure was built for the Molded Fiber Glass Research Co., which is jointly owned and supported by the five companies. It is designed as a centralized labora-

(Continued on page 457)



Make a Powerful, Long-Running Motor

USING A NEG'ATOR® SPRING

Using the NEG'ATOR constant-tension spring, a powerful long-running motor can be made by winding the NEG'ATOR band on a storage drum then *reverse-bending* the free end around a larger, output drum. The tendency of the material to recurl to its *preset curvature* around the smaller drum imparts a more constant output torque to the shaft of the output drum.

As the illustration shows, Eastman Kodak engineers have designed a NEG'ATOR Spring motor and have applied this motor to their new 16 mm Cine-Kodak K-100 Movie Camera. In this application, the NEG'ATOR motor drives the film and provides much longer film footage per wind than is possible with a conventional power spring—40 feet of film per wind, 100 seconds of exposure at the normal 16 frames per second speed.

By using a NEG'ATOR Spring as shown, Eastman Kodak's engineers obtained advantages in addition to longer film footage. The motor eliminates extreme torque variation and wasteful high torque output at full wind. It cannot "jump" or "skip" (solving a major camera-drive problem). It simplifies design of gearing and governor, requires no lubrication, permits full utilization of the work potential of the spring, and reduces over-all cost.

Used as a motor, as shown, or as a constant-tension extension member, a band, clamp, or clip, the NEG'ATOR might be just what you're looking for. You can learn more about the NEG'ATOR by reading Bulletin 310N which is available on request. Or write on your company letterhead for a sample NEG'ATOR Spring.

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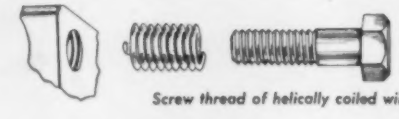
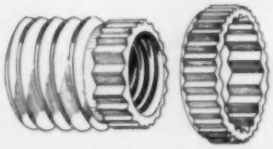
SPRINGS • STAMPINGS • TEST APPARATUS

Light metals design tips



Screw thread of helically coiled wire.



Screwed-in bushing with locking ring.

Use of screwed-in inserts increases design possibilities of magnesium

Use of screwed-in inserts is another development which makes magnesium suitable for an ever widening range of product uses. Here are a few basic facts about the types of screwed-in inserts shown above.

Screw thread of helically coiled wire—This coil type of insert is a thread lining made up of a precision shaped helical coil of spring wire used between the tapped hole and the mating bolts. For best results, coil inserts should be inserted to a depth of 2½ times the diameter when using heat-treated steel bolts. For mild steel bolts, a depth of 1½ times the diameter is suggested.

Screwed-in bushing with locking ring—Tubular in shape with threads cut in the exterior surface, this insert is installed by screwing into a threaded hole in the magnesium part. Used for bearings and bushings, it can also be threaded on the inside for the attachment of studs or bolts. The strength ratio of inserts to bolts or studs should be such that the bolts or studs fail in torsion instead of stripping the inside threads of the inserts.

Whatever your light metals problem, you can count on Magcoa engineering counsel and fabricating facilities. Write today for a free copy of our Magnesium Design Handbook.

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LIGHT METALS FABRICATION DIVISION • EAST CHICAGO 27, IND.

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COOLANT UNIT
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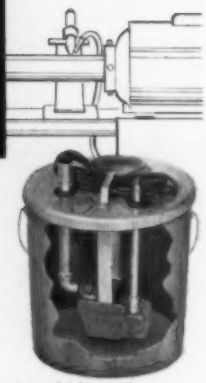

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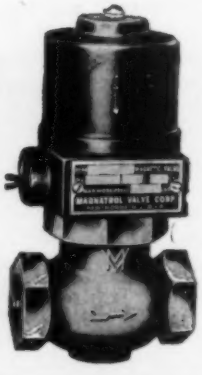

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tory for research and testing work on raw materials, processes and finished products in the field of fiberglass reinforced polyester resin. Experimental and development work in other reinforcements and resins will also be done in the new laboratory, as well as equipment and process engineering.

Plant for Control Instruments Expanded

Construction has begun on a $1,500,000 research and development building for the Scientific Instruments Div., of Beckman Instruments, Inc., Fullerton, Calif. The unit, which will add 100,000 sq ft of floor space to the present facility, will permit expansion of the employee force from the present 1000 to between 1500 and 1700 persons. It will bring to 304,000 sq ft the total operating floor space on the 40-acre Beckman site.

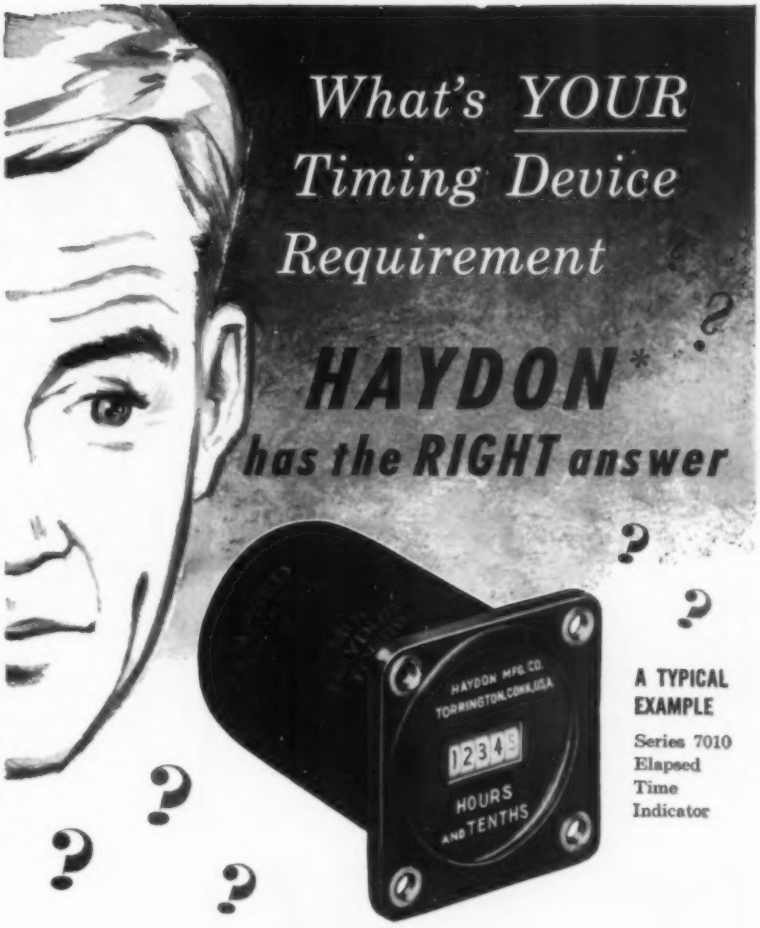
A feature of the new building is a "core of quiet" area for engineering activities. This area will be located in the center of the structure and walled off from such noise-producing functions as laboratories and the model shop which form the perimeter of the building. The expansion will be completed by October. The company's Fullerton division produces a variety of analytical and measuring instruments for laboratories, continuous-monitoring instruments for industrial process control and automatic data processing systems for industrial control and developmental work in fields ranging from atomic power to advanced jet engines.

New Plant for Sheet Metal Fabrication

Announcement of plans for a $1-million expansion program was made by Aircraft Products, Inc., Dayton, Ohio. The first phase of the expansion was the purchase of a new plant in Forest, Ohio, which doubled production capacity for aircraft quality sheet metal assemblies. The second phase was the purchase of new machinery for welding, press work and assembly. The new plant will be fully equipped and in operation in March.

Employment will be approximately

(Continued on page 459)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A TYPICAL EXAMPLE
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THE RIGHT MOTOR . . . *unusually compact, fully enclosed mechanism, controlled lubrication, simple, accurate and dependable, operates in any position.*

THE RIGHT DESIGN . . . *for any application because you can select from the full line of HAYDON STANDARD interval timers, time delay relays, cycle timers, and elapsed time indicators.*

THE RIGHT FACILITIES . . . *because HAYDON has the fully integrated engineering and manufacturing facilities to produce and deliver quality on time . . . economically . . . in large or small lots.*

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G-211 solenoid, 10 lbs. at 85% voltage, 1½" stroke.

NA-726 solenoid; 16 lbs. at 1" stroke, 100% voltage.

G-200 line of solenoids. Replacement for all sizes of General Electric Co.'s CR-9503-200 line of solenoids.

NA-700 line of solenoids, replacement for National Acme solenoids, size for size, for all modifications.

The solenoids of both the above replacement lines are all thoroughbred Trombetta solenoids. All dimensions of interest to the user are the same as the respective solenoids they replace. The pull and pull characteristics are identical. In either case, we are in a position to furnish replacement units for any and all modifications. They are available for all voltages and frequencies, including direct current.

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- . . . allowed load increase from 3 H.P. to 5 H.P. on worm gears of single reduction speed reducers. (Field Report 24-41)
- . . . increased cycles from 28,000 to 700,000 in tests on brass taper air valves. (Field Report 4)
- . . . raised Oilite bearing life from 6 to 46 hours. (Field Report 24-47)
- . . . raised life to failure time from 120 to 400 hours on sintered bronze bearings; reduced wear in 12 hour test from .002 to .001. (Field Report 43)

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150 to start with and 300 when production is in full swing. The company manufactures aircraft accessories, heat exchangers, valves, actuators, hydraulic measuring devices and other components of aircraft quality for control of fluid flows and temperatures. Production at the Dayton plant will continue where the model and prototype shops, as well as research and wind tunnel facilities are available.

Plastic Tube Plant

A new plant devoted exclusively to the production of PVC pipe and tubing has been completed by Alpha Plastics, Inc., Livingston, N. J. The 12,000 sq ft facility will aid in the production of ½ to 4 in. pipe in 10 and 20 ft lengths as well as PVC valves and fittings.

Molded Seal Company Expands

Linear, Inc., producers of precision molded seals, has announced the purchase of a 124,000 sq ft plant in Dallas, Pa. The selection of the Dallas site for relocating production facilities was partially based on the ready labor supply. The move to the new location will bring to Dallas an annual payroll of approximately $2 million, and will open up jobs for between 450 and 500 people.

Electronics Corporation Formed

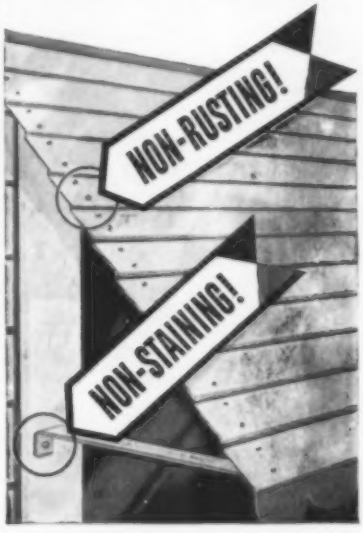
Verrall Moe Electronics Inc., with general offices in Jefferson, Wis., has been formed to manufacture and promote a new electrical conductor for radiant heat that can be sprayed, rolled or printed on the surface of any shape or contour, eliminating the need for resistance coils.

Bearing Company to Build New Laboratory

A modern two-story steel frame building containing approximately 10,000 sq ft on each floor will be erected by The Timken Roller Bearing Co., Canton, Ohio. The building

(Continued on page 461)

How Alcoa Aluminum Fasteners make good awnings even better



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Gentlemen:
Please send complete specification data and samples of Alcoa Aluminum Fasteners.

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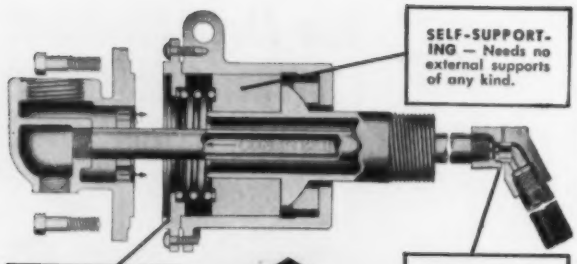
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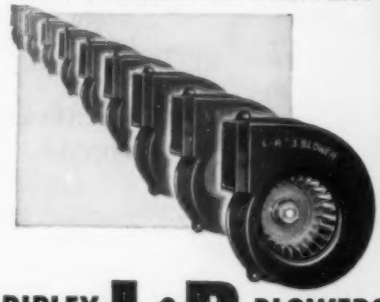

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costing $1.5 million, will house the company's physical, railroad research, electronic, photographic and lubrication laboratories. Included in the new facilities will be a 700-hp transmission and axle dynamometer, cold-test room, a hot-test room, six radial and thrust test machines and a new universal testing machine. Construction is expected to get under way in May.

Servomechanisms, Inc., Expands

Plans for the construction of a million-dollar plant in Nassau County, N. Y., for Servomechanisms, Inc., have been announced by company president, William W. Shannon. The 55,000 sq ft plant will house engineering and production operations of the Subsystems Group of the Company. Servomechanisms, Inc. manufactures electronic and electromechanical subsystems and computers. The new facility, which will be completed late this year, is part of an expansion program for the Subsystems Group. Another plant for this Grouop, located in Westbury, Long Island, will remain in operation after the new plant opens.

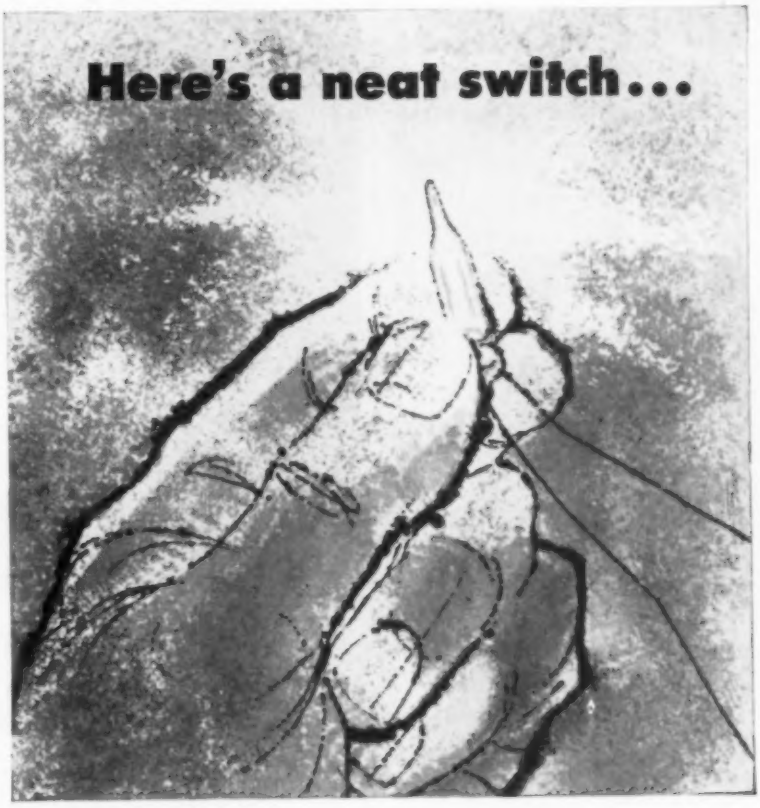
Near Gear Company

In order to coordinate the research and manufacturing facilities of Massachusetts Gear & Tool Co., Woburn, Mass. and Gear Systems, Inc., W. Concord, Mass., a new organization, Geartronics Corp., has been formed. The new company, located in Woburn, Mass., will provide facilities for the production of both precision and commercial gears and gear systems, as well as research and development for industrial and military applications.

Industrial Engine Plant And Research Center

The Caterpillar Tractor Co., Peoria, Ill., has announced plans to construct a 500,000 sq ft industrial engine plant, a research center and a general office building on a 1100-acre site in Peoria. Construction for the

(Continued on page 463)



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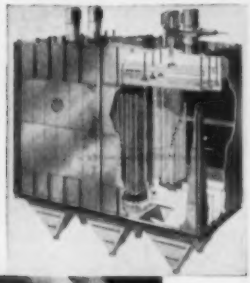

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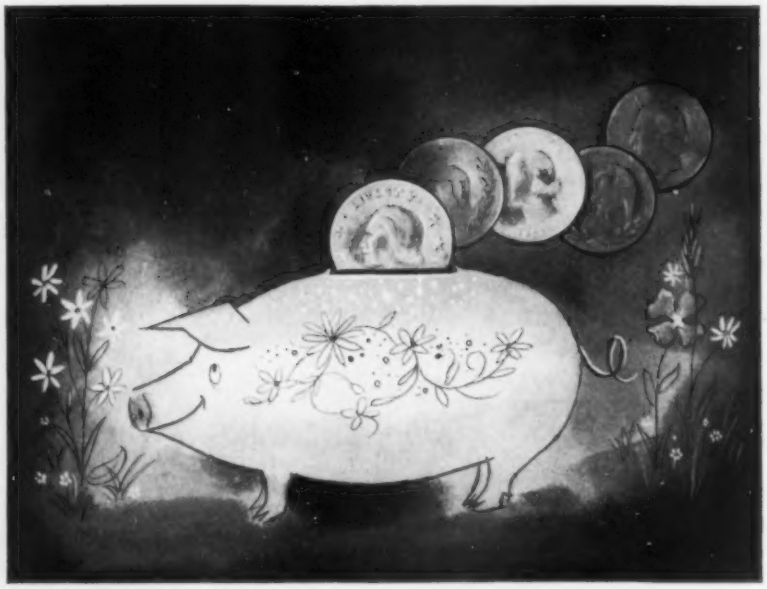

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engine plant will begin within the next few months, and the research center and office building soon after. Total cost of the multi-building expansion has been estimated in excess of $200-million for the next three years. It is expected that approximately 3500 people will be employed in the new area when all facilities are completed. Of this number, about 1200 will be employed in the industrial engine plant.

Bearing Plant Expanded

The addition of new items to its line has resulted in the announcement of a $1.5 million expansion program for the McGill Mfg. Company's bearing division, Valparaiso, Ind. The new program call for the expenditure of approximately $900,000 for new machines and equipment. An additional $600,000 will be spent for construction of 45,000 sq ft of additional manufacturing space. Building and equipment are scheduled to be completed by May. Expansion will increase the manufacturing capacity of the bearing division by 35 per cent. New type bearing in this program include Multirol, Guiderol full-type needle roller bearings, Camrol cam follower roller bearings, and a line of special ball bearings.

Potentiometer Plant Expanded

The Technology Instrument Corp., Acton, Mass., has completed a half-million dollar, two-story addition to its plant in Acton. Designed for continued production of precision potentiometers, the expansion is expected to increase production capacity by as much as 100 per cent.

New Office Building For Union Carbide

Towering some 750 ft above street level in mid-town New York City will be a 52-story office building to house the home offices of Union Carbide and Carbon Corp. The building, constructed of stainless steel and glass, will contain approximately 1,500,000 sq ft of office space. Execu-

(Continued on page 465)

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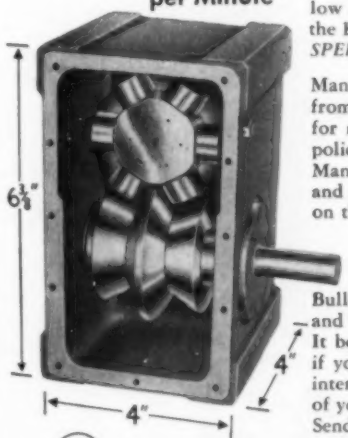

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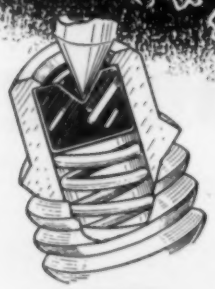

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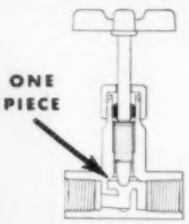

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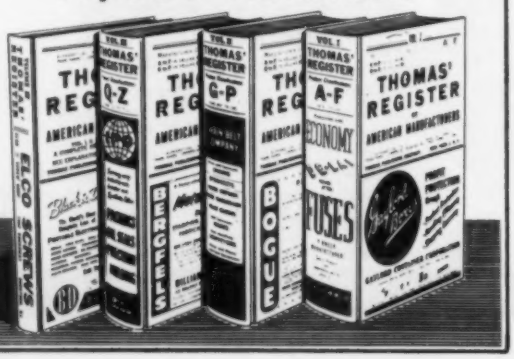

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tive offices of the company and its divisions will occupy the major portion of the building. The project is expected to be completed in the early part of 1960 at an estimated cost of $46 million.

Name Changes

Tri-Point Plastics, Inc., is the name adopted for all divisions of the Tri-Point group of companies: Tri-Point Manufacturing and Developing Co., Tri-Point Manufacturing, Inc., and Tri-Point Insulation, Inc. The company is located in Albertson, N. Y.

Daco Machine and Tool Co., Brooklyn, N. Y., changed its name to Daco Instrument Co. Of late, the company's work has been concentrated in the design, prototype-making, manufacturing and assembly of precise electro-mechanical instrumentation.

New Divisions

Pratt & Whitney Co., Inc., West Hartford, Conn., has created a Materials Handling Dept. to function as part of the company's service department.

Dow Corning Corp., Midland, Mich., has established a New Products Dept. This new department is a result of expansion in the silicone industry as well as an increase in the number of new silicone products.

Allen B. DuMont Laboratories, Inc., Clifton, N. J., has formed a Data and Display Dept. to develop and study electronic equipment.

Gulton Industries, Inc., Metuchen, N. J., has established a new division which will encompass research development and production in the fields of high frequency telemetering systems and related communications devices, ultrasonic dryers, solar furnaces and geophysical equipment. The new division will be located in Albuquerque, N. M.

Sullivan Powdered Metals, Inc., Cleveland, Ohio, has formed a Research and Development Div. The new division will be devoted exclusively to the development and application of special blends of aluminum

(Continued on page 467)

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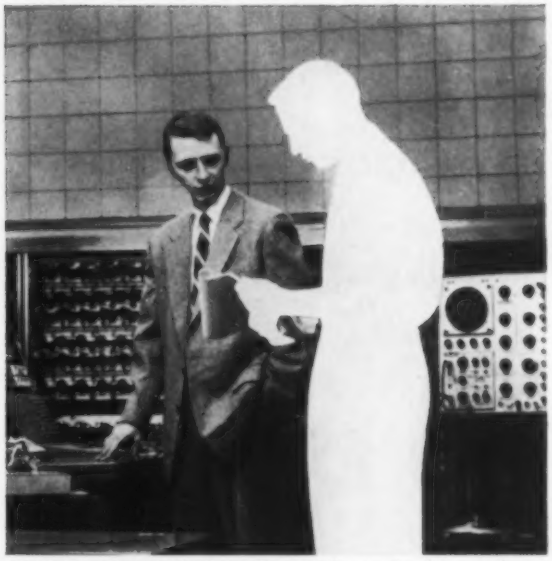

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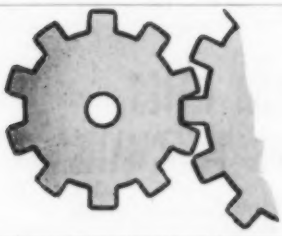

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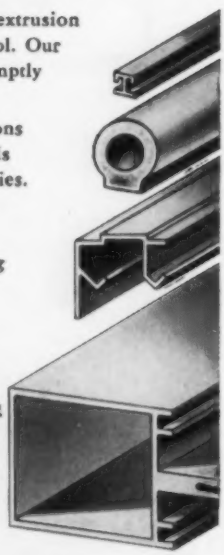

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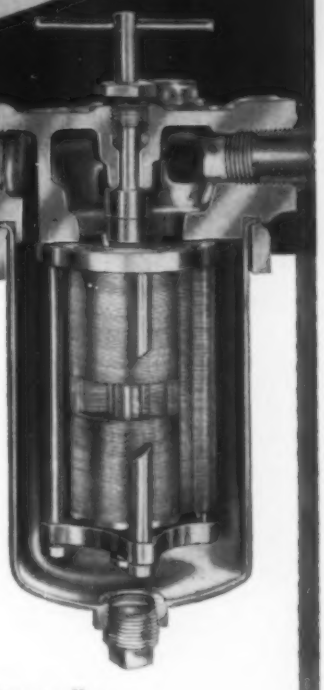

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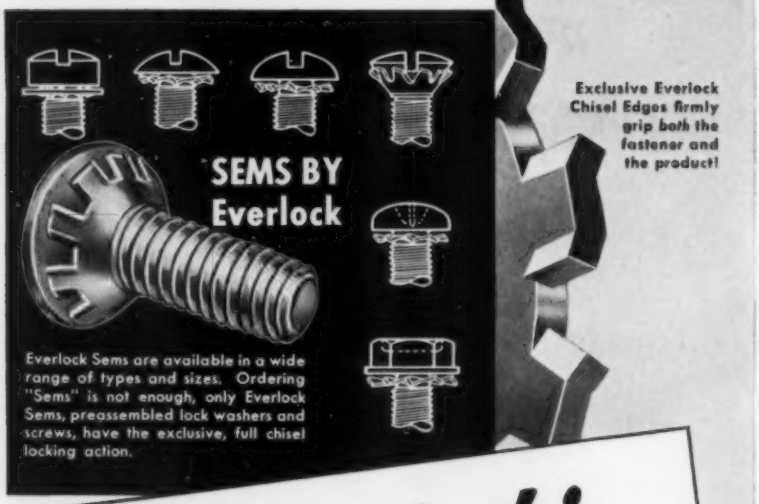
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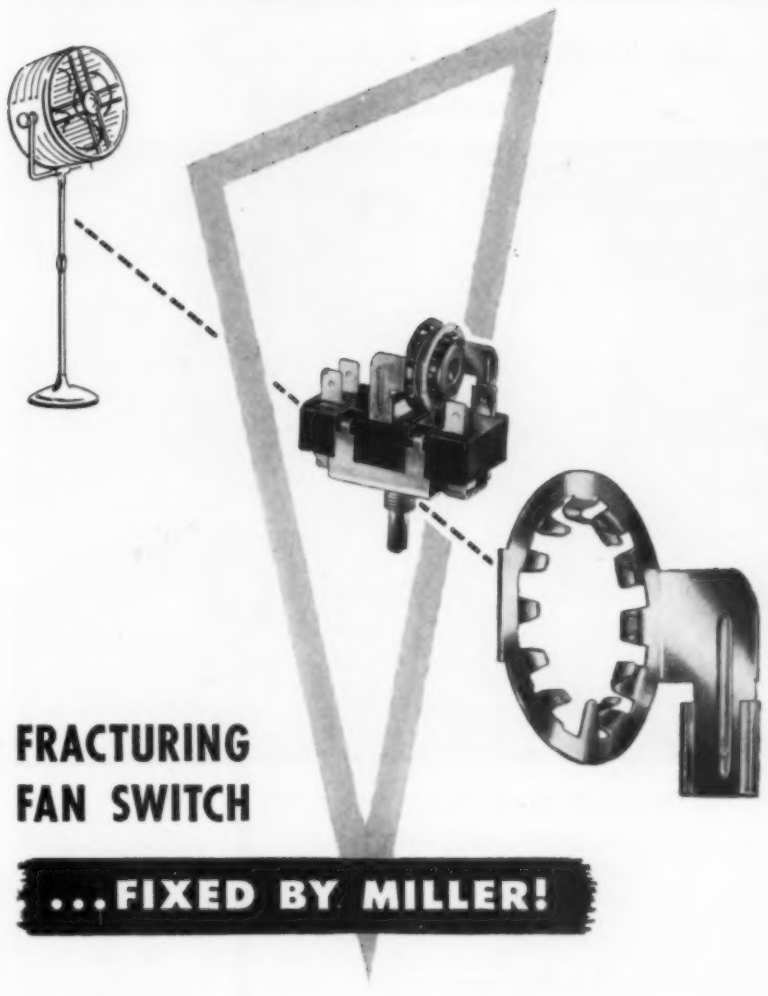

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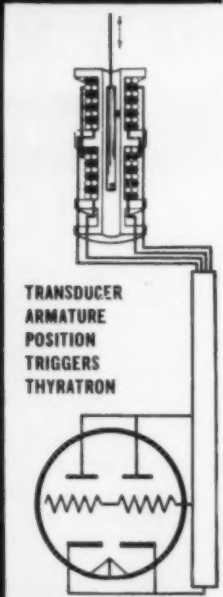

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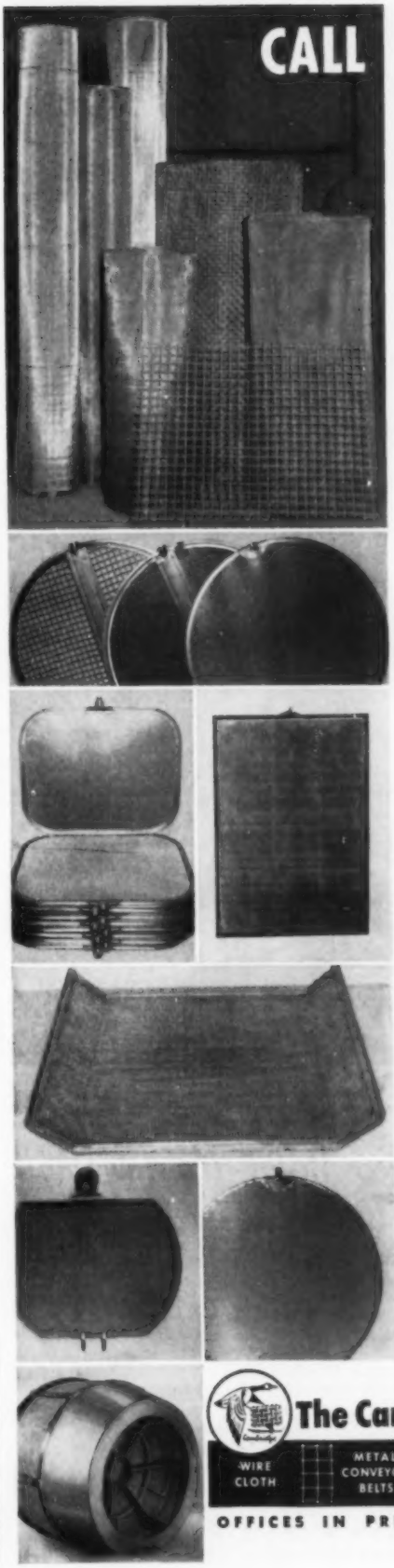

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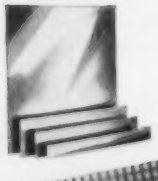

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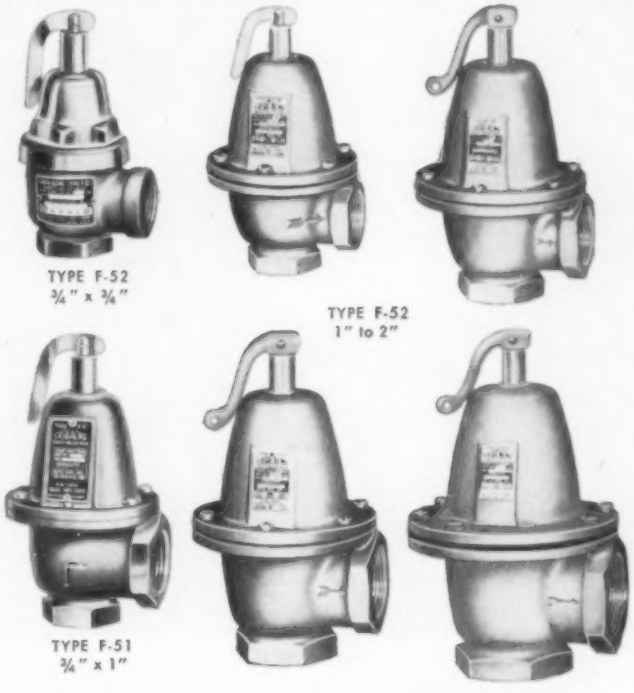

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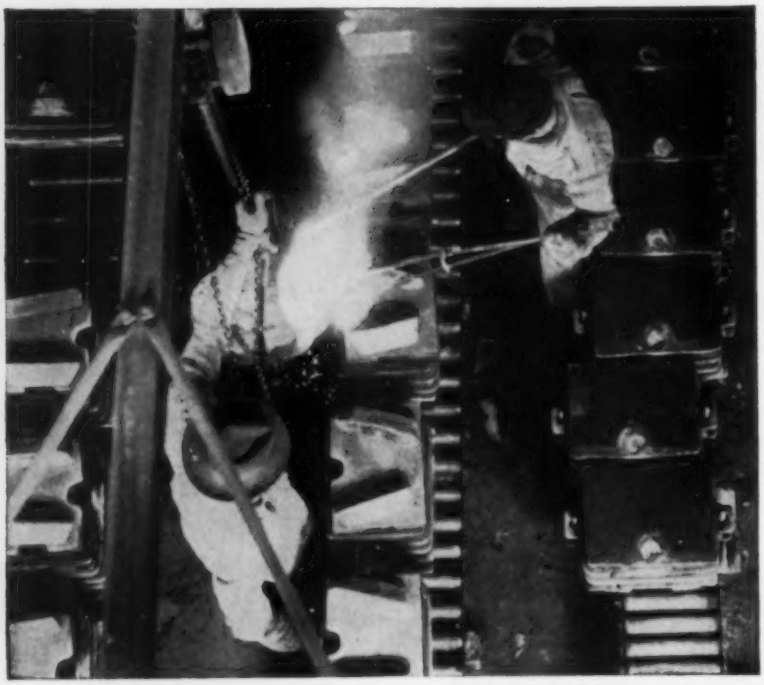

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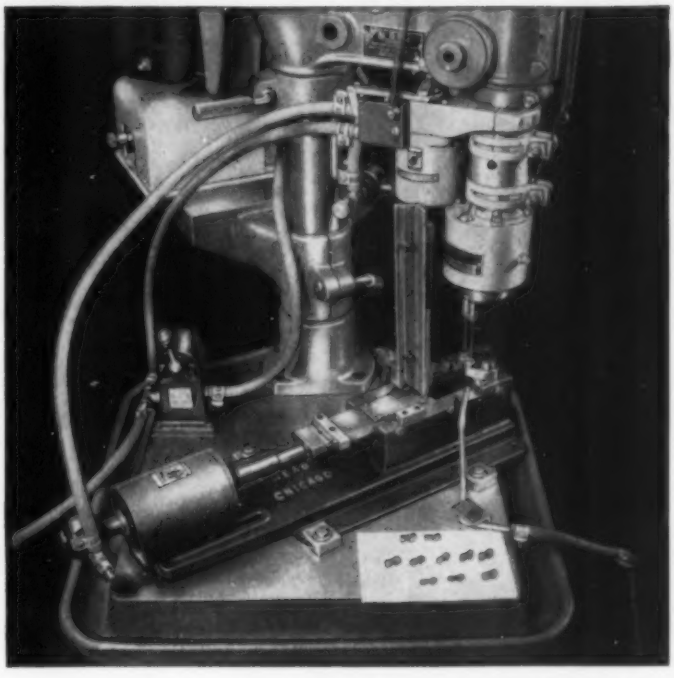
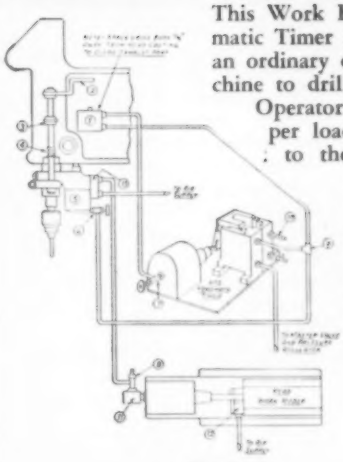
AUTOMATION WITH AIR POWER





This Work Feeder, with the aid of a Mead-matic Timer and Drill Press Feed, transforms an ordinary drill press into an automatic machine to drill twin holes in Chain saw links. Operator merely keeps the vertical hopper loaded — the machine delivers them to the drills, holds them firmly and ejects them when finished. Material is tough alloy steel, ranging in thickness from ⅛" to ¼". Hole spacing is held to .0005" by bushings mounted in plate with micro adjustment. Production is 600 to 900 per hour, depending on thickness.

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MEAD SPECIALTIES COMPANY
4114 N. Knox Avenue, Dept. PE-37, Chicago 41, Illinois

PATHFINDER IN AIR POWER AUTOMATION

How CHACE Thermostatic Bimetal Actuates the FRANKLIN DALES Temp-Guard

A Product of
The Franklin Dales Co.
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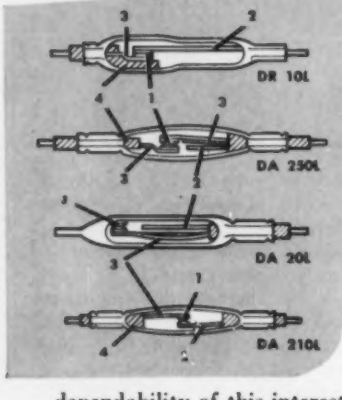
Akron, Ohio



The Temp-Guard is an extremely compact, self-contained and sealed tubular type circuit breaker manufactured by The Franklin Dales Co. Numerous variations of standard models are used in applications such as electric motors, operating on-off cycling systems, detecting fire and activating alarms, protecting electrical appliances, controlling regulating systems, automatically making or breaking current to solenoids, transformers, etc. The accuracy and dependability of this interesting device hinge upon its actuating element of Chace Thermostatic Bimetal.

The photo shows a typical Temp-Guard actual size. Others vary from 1 5/16" to 3 3/8" in length. The sectional drawings show four representative types of circuits; the DR models have the thermostatic bimetal element in contact with the case; the DA models have element insulated from the case. The numeral "2" indicates that case does not carry current. Parts numbered in the drawings are:

1. Contacts
2. Thermostatic Bimetal Element
3. Conductive Strip
4. Insulation

In all examples, the bimetal element deflects in response to changes in ambient temperature or heating of the element due to overload, making or breaking the circuit.

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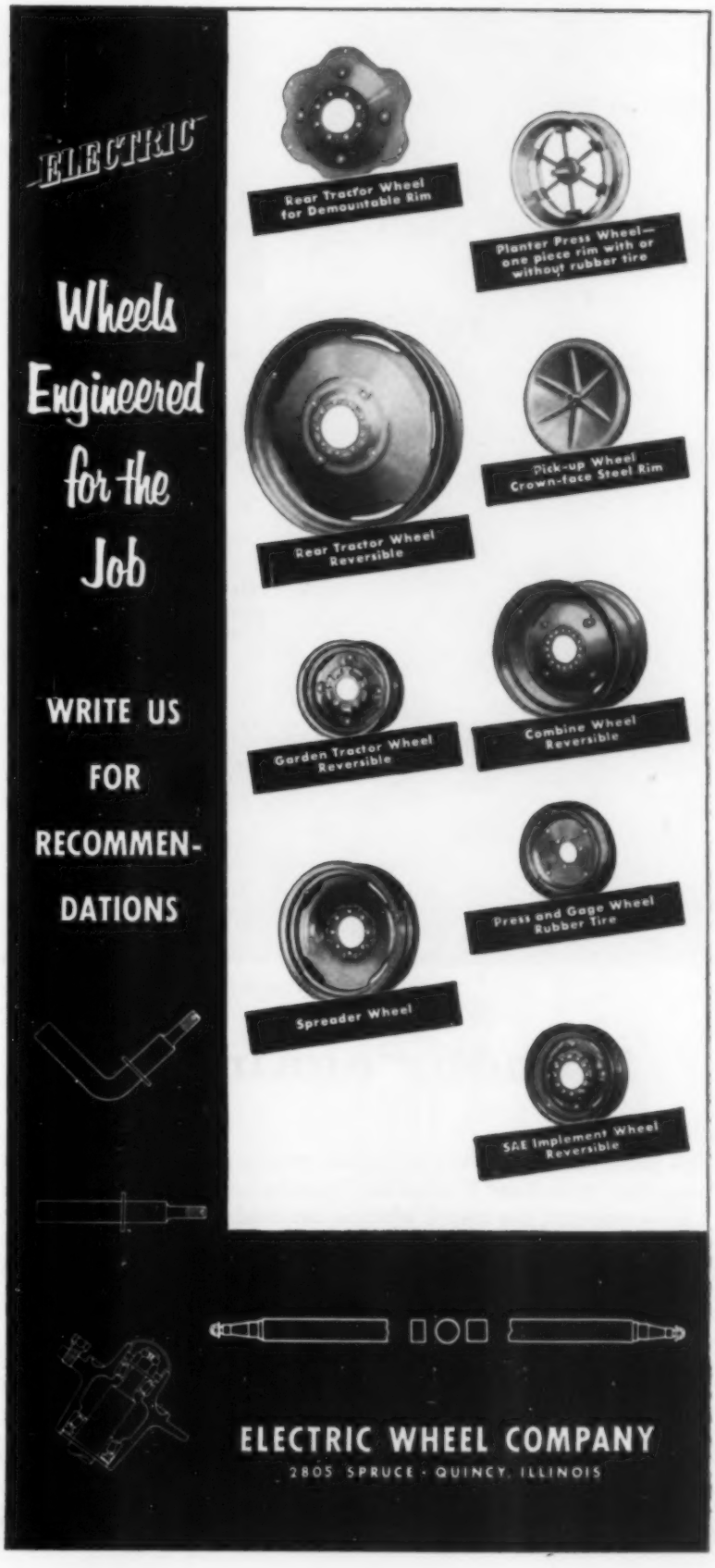
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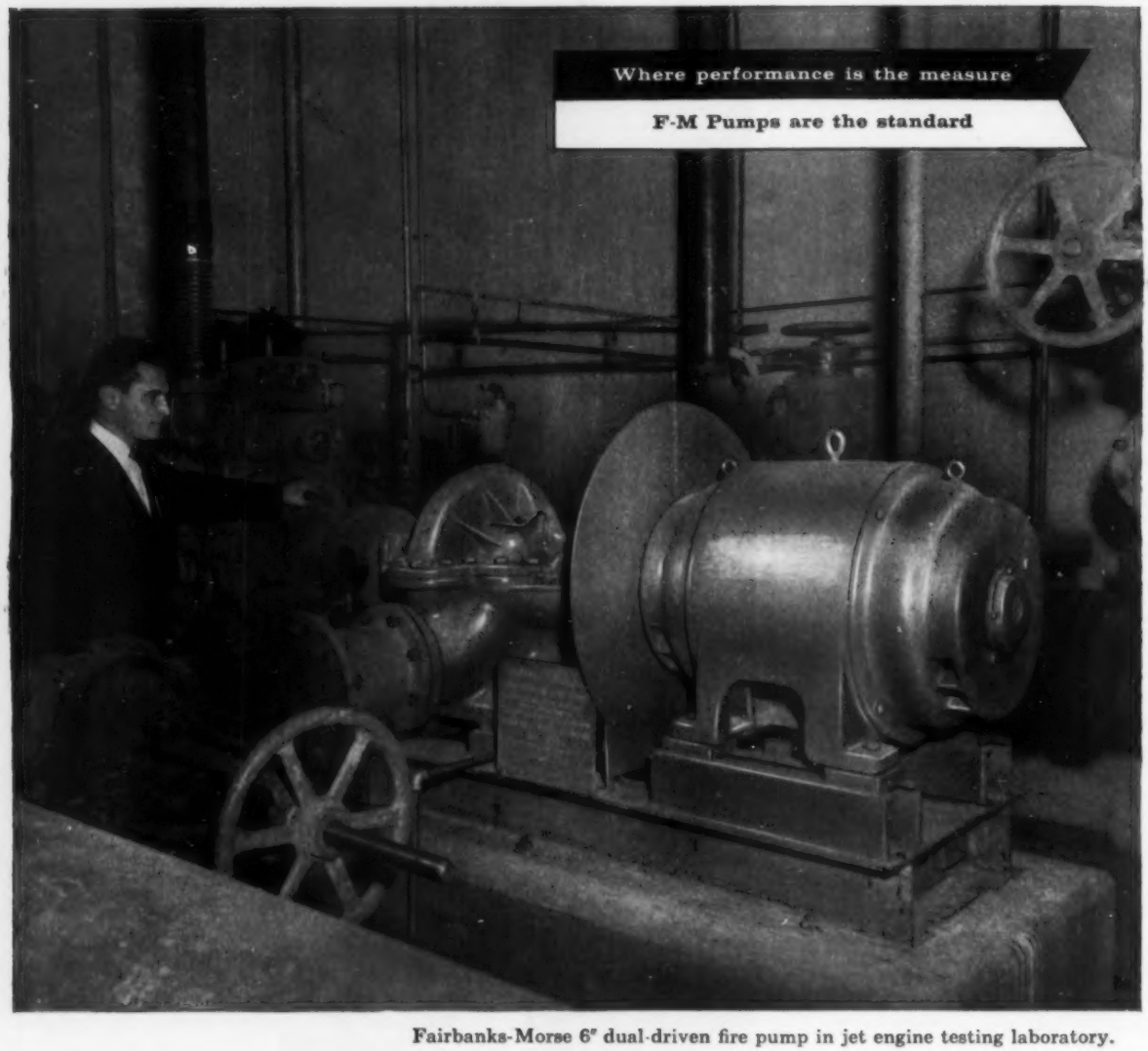

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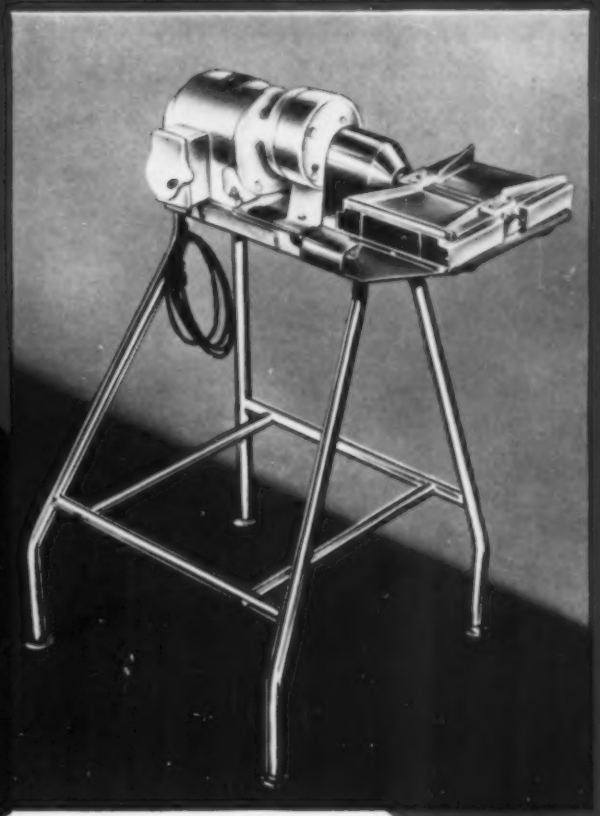
THERE'S MORE THAN ONE WAY TO SKIN A GIZZARD!



Power Gizzard Skinner Means Better Production for packers! Driven by a Master ¼ H.P. Double Parallel Gearmotor, output speed 230 R.P.M.

ANOTHER DRIVE REQUIREMENT MEETS ITS MASTER

"But my drive problems are different," you say, and right you undoubtedly are. Far as we know, this Master-powered Gizzard Skinner is unique.

But here's the point. America's productive genius consists of the ability to analyze a problem, devise a system and apply power to it in such a way as to produce better results faster at less cost. And *that problem* we bet you've got!

Let us help! Tell us the problem. From the drives listed here—or a combination of the required ones in one compact efficient unit—we'll deliver the goods! That's just what we've done for many, many years, to an ever-enlarging cross-section of American industry jealous of the performance of their motor equipment.

Motor Ratings..1/8 to 400 H.P. All phases, voltages and frequencies.

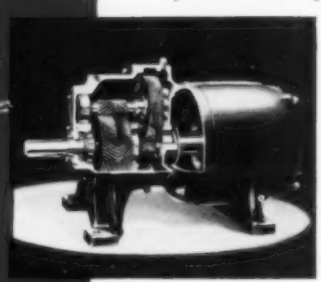
Motor Types.....Squirrel cage, slip ring, synchronous, repulsion-start induction, capacitor, direct current.

Construction.....Open, enclosed, splash-proof, fan-cooled, explosion-proof, special purpose.

Speeds.....Single-speed, multi-speed, and variable speed.

Installation.....Horizontal and vertical, with or without flanges and other features.

Power Drive Features.....Electric brakes (2 types)—5 types of gear reduction up to 432 to 1 ratio. Mechanical and electronic variable speed units—fluid drives—every type of mounting.



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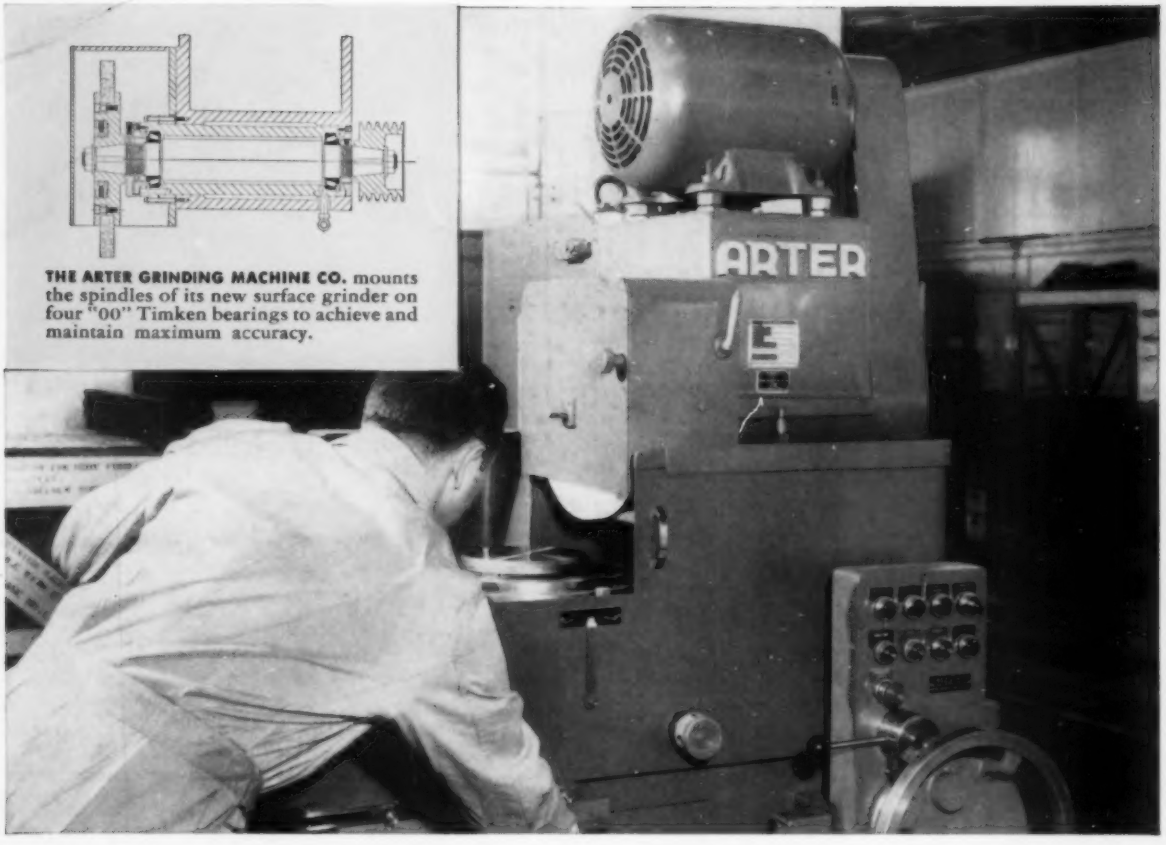

THE ARTER GRINDING MACHINE CO. mounts the spindles of its new surface grinder on four "00" Timken bearings to achieve and maintain maximum accuracy.

New precision grinder costs less to make, gives smoother spindle operation with TIMKEN® bearings

TO get the smooth spindle operation required for the extreme precision of their new surface grinder, The Arter Grinding Machine Company mounted the work spindle and the wheel spindle on four "00" Timken® tapered roller bearings. The extremely low run-out tolerances of Timken "00" bearings—75 millionths of an inch—make possible the closest machining tolerances ever achieved. And by using two Timken precision bearings on the spindle, Arter got greater capacity in less space—cut manufacturing costs ⅓ over earlier spindles used.

Timken "00" precision bearings not only deliver highest precision, but like all Timken bearings, they take both radial and thrust loads in any combination. And full line contact between Timken bearing rollers and races gives them extra load-carrying capacity. Shafts are held rigid — accuracy is maintained — gear life increased. Timken bearings run smoothly because they practically eliminate friction. They're designed by geometric law to have true rolling motion and precision manufactured to live up to their design. Normally last the life of a machine they're in.

The Timken Company developed "00" bearings to meet the demands of today's new precision machine tools. To produce these bearings, the Timken Company perfected measuring devices of unprecedented precision and developed new manufacturing techniques. The "00" bearing has achieved twice the precision of any previous Timken bearing.

Whatever machines you buy or build make sure your bearings are the best. Look for the trade-mark "Timken" on every bearing and be sure of maximum life, dependability, and minimum maintenance. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.

TIMKEN

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TAPERED ROLLER BEARINGS ROLL THE LOAD